N.C.
K.3

DRIFT-PLATTEVILLE AQUIFER SOURCE CONTROL WELL PLAN

CONTENTS

SECTION A
SITE MANAGEMENT PLAN

Well Location

Section 9.1.1 of the Remedial Action Plan specifies criteria for location of the Drift and Platteville source control wells. The wells must be located within 500 feet downgradient of existing monitoring well W13 and must be capable of controlling ground-water flow from beneath the bog (bounded by Walker Street on the north, temporary Louisiana Avenue on the east, Lake Street and the South Frontage Street Extension on the south, and a north-south line through the intersection of Walker Street and 37th Street on the West).

The source control well location indicated in Figure 1 meets the RAP requirements. In addition, the proposed location is practical since it is on property owned by the City of St. Louis Park.

Well Design, Drilling Plans and Procedures

The design, drilling plans and procedures for construction of the Drift and Platteville Aquifer source control wells will accommodate a 4-inch submersible pump.

The Drift Aquifer source control well is designed to intercept water over the full thickness of the aquifer (Figure 2). Appendix A includes the boring log and grain size analysis for a boring installed in the immediate vicinity of the proposed Drift source control well. The boring log indicates that the Drift Aquifer does not contain confining beds at this location. Thus, screening the full thickness of the aquifer will not result in interconnected water bearing zones.

Design considerations for the Drift source control well are as follows:

- The well will be drilled using direct rotary drilling techniques to the depth of the top of bedrock (approximately 65 feet). A nominal 10-inch

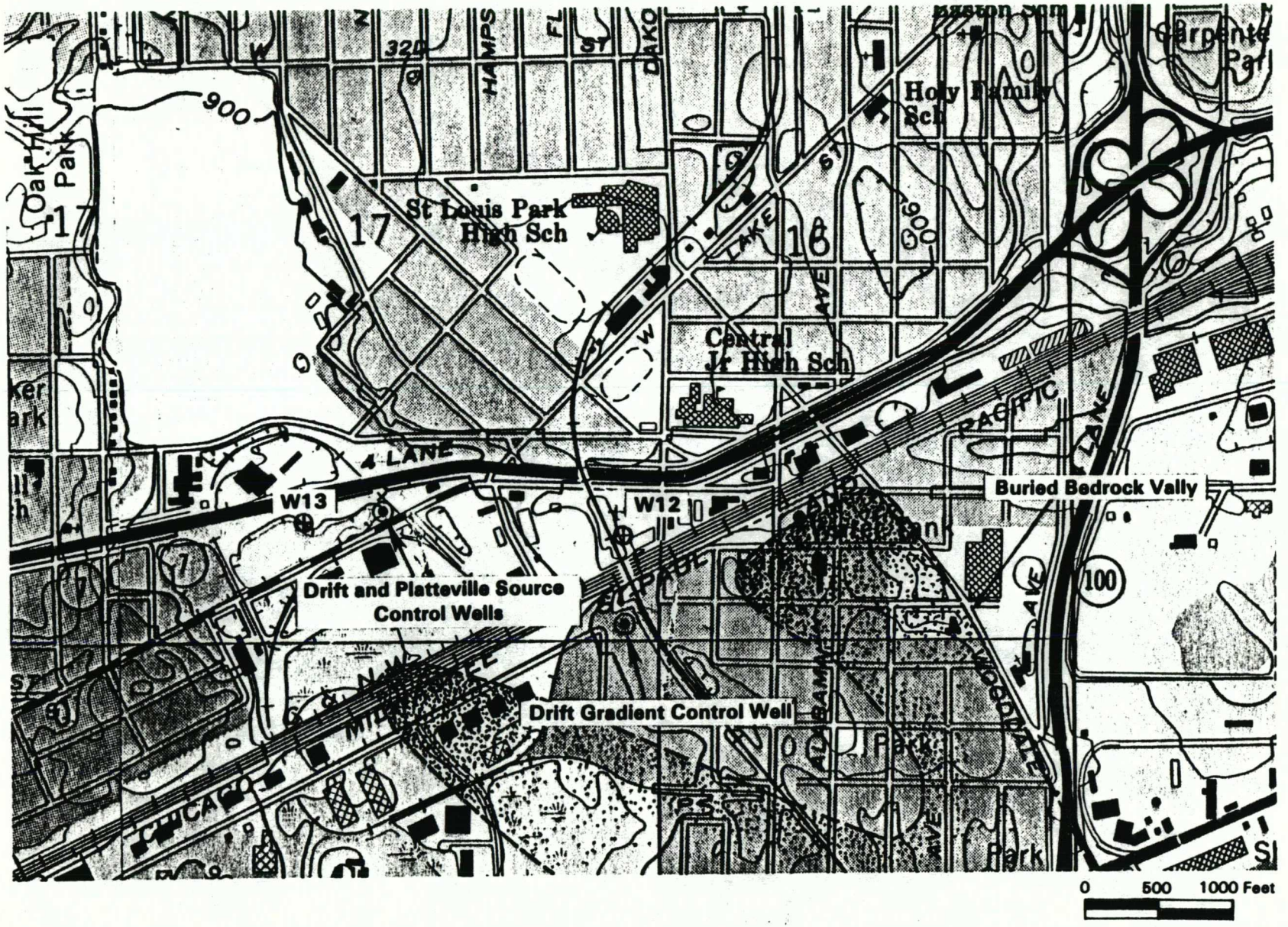
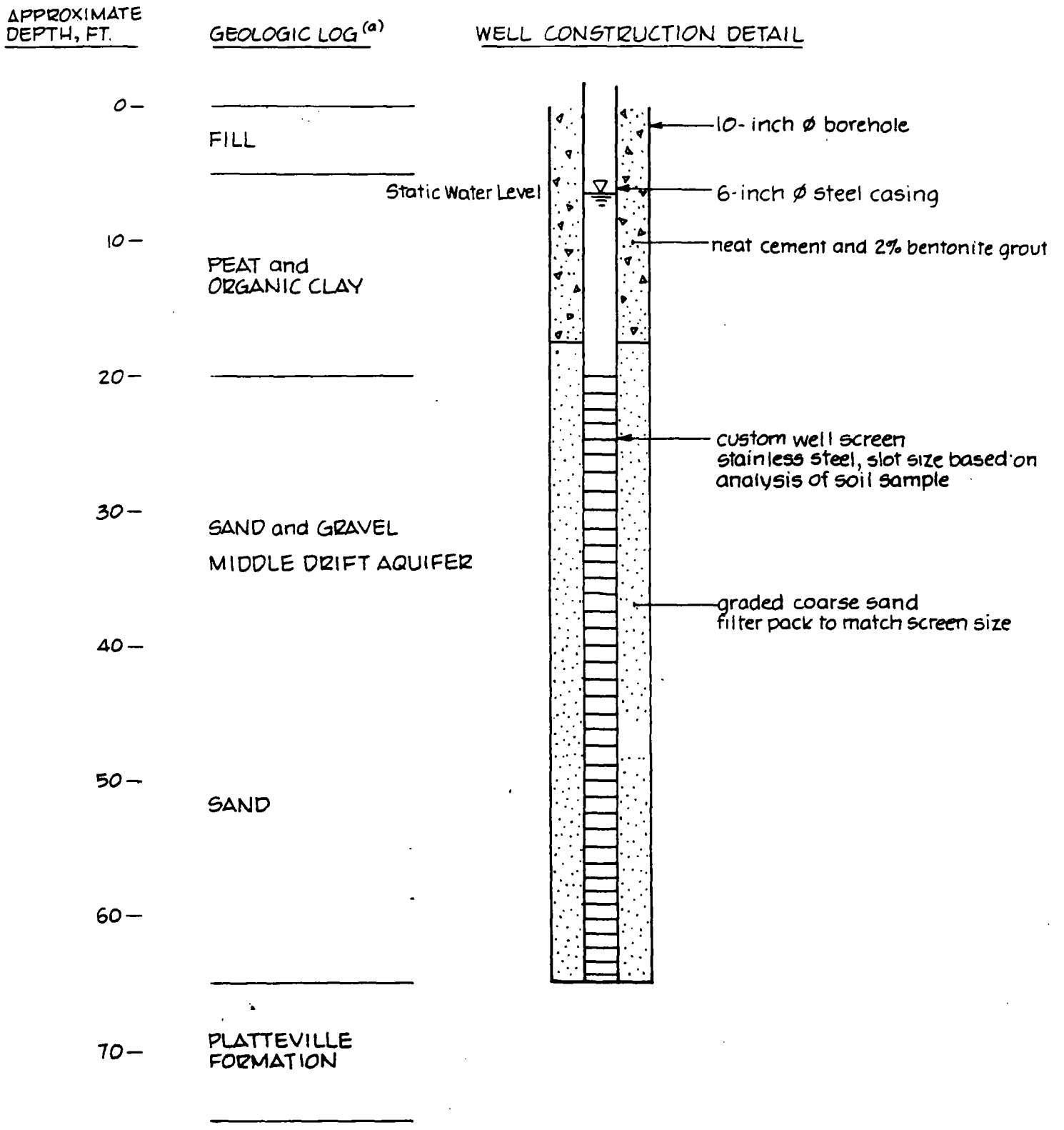


Figure 1 Proposed Locations of Drift and Platteville Control Wells



(a) Based on the log for boring B-11 by Barr, 1976.

Figure 2 Drift Aquifer Source Control Well Design

hole will be drilled to allow for proper grout seal of the 6-inch well casing. A minimum bit size of 10 inches will be used to comply with the MDH well code requirement of 4 inches between casing and borehole diameters.

- Continuous split-spoon samples have been collected in order to define the stratigraphy at this location and to provide samples for mechanical grain size analysis. (See Appendix A.)
- The well will be screened in the Drift from the top of the Platteville to the bottom of the surficial peat/organic clay layer. This will be about 50 feet of screen in a 65-foot well. The well screen will be constructed of stainless steel.
- The well screen slot size will be based on mechanical sieve analyses of soil samples retrieved from the elevation at which the screen will be placed. A slot size that will hold out 40 to 60 percent of the material will be used. Additionally, the screen intake velocity will be less than 0.1 foot per second.
- The steel well casing will extend from the top of the well screen to the ground surface (leaving an appropriate stickup for a well head). The well casing will be pressure grouted using a 2% bentonite neat cement grout mix.
- Upon completion of the well, a gravel pack will be developed around the well screen by a high velocity jetting and pumping technique.
- Upon completion of the well, a reference point for measuring water levels will be established at the well head. The horizontal location and vertical elevation of this reference point will be surveyed.

The Platteville Aquifer source control well is designed to intercept ground water over the full thickness of the aquifer (Figure 3). Design consideration for the Platteville limestone source control well are as follows:

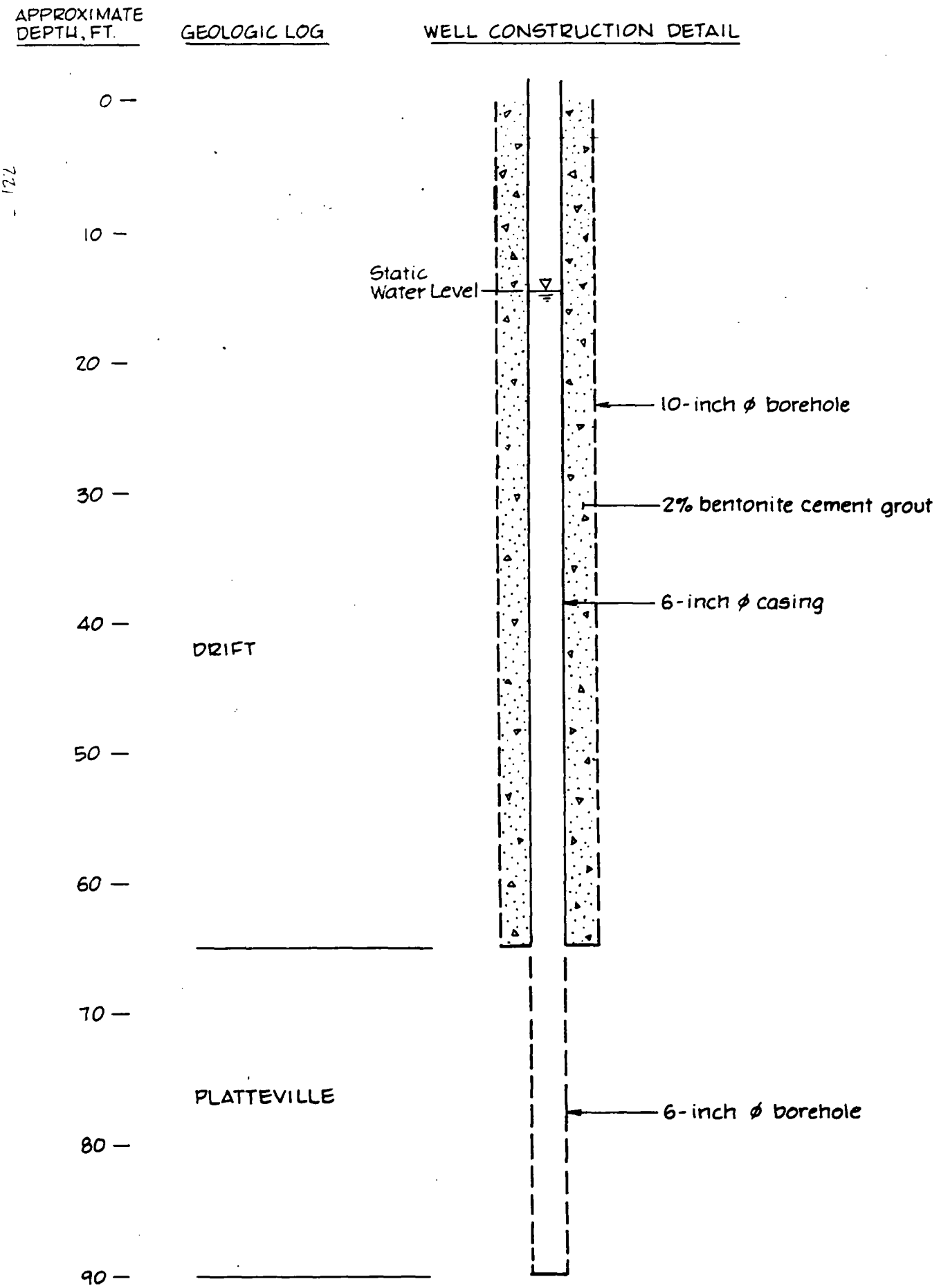


Figure 3 Platteville Aquifer Source Control Well Design

- Direct rotary techniques will be used to drill a 10-inch borehole to a depth of approximately 65 feet (the top of the Platteville formation). A minimum bit size of 10 inches will be used to comply with the MDH well code requirement of 4 inches between casing and borehole diameters.
- A 6-inch diameter steel well casing will be seated and grout sealed at the top of the Platteville limestone formation.
- The bedrock below the well casing will be drilled using direct rotary techniques. A 6-inch borehole will be drilled through the Platteville Aquifer and terminating in the Glenwood Shale.
- Upon completion of the well the open bedrock will, if necessary, be developed to remove the finer grained material and drill cuttings using a high velocity jetting and pumping technique.
- Upon completion of the well a reference point for measuring water level will be established at the well head. The horizontal location and vertical elevation of the reference point will be surveyed.

A licensed well driller will be contracted to install the source control wells. The licensed well contractor will use direct rotary techniques to advance the boreholes. Casings will be grouted into place with a tremie pipe. All grout and other material specifications will conform with the requirements of the Minnesota Well Water Construction Code. The drilling site will be kept neat and clean at all times. Drilling fluids, cuttings, and other debris will be handled in accordance with the Contingency Plan (Appendix E). Drilling tools and equipment will be steam cleaned before and after drilling. A record containing documentation of these procedures, field notes, well logs, measurements, etc., will be maintained.

Pump Specifications and Installation

The monthly average pumping rate specified by the RAP for the Drift source control well is 25 gallons per minute. The total head lift that the submersible pump will be required to overcome will be no more than 110 feet (Appendix B). A 4-inch diameter, 3-phase, 2 horsepower submersible pump will be required to achieve the 25 gpm pumping rate and total head lift.

The pumping rate specified by the RAP for the Platteville source control well is 25 gallons per minute. The total head lift that the submersible pump will be required to overcome is estimated to be 110 feet (Appendix B). A 4-inch diameter, 3-phase, 2 horsepower submersible pump will be required. A Grundfos Model SP6-10 pump or equivalent will be used in each source control well. The specifications and rating curve for this pump are shown in Figure 4.

The construction materials for the Drift-Platteville submersible pumps and discharge pipes will be as follows:

- The submersible pumps will be constructed of stainless steel.
- The submersible pumps' natural butanol rubber (NBR) impeller seal ring will be retrofitted with teflon.
- A 2-inch national pipe thread (NPT) discharge pipe will extend from the pump outlet to the point of discharge. The discharge pipe will be constructed of galvanized steel.

The submersible pumps will be installed within the Drift-Platteville source control wells safely below the pumping water level, as determined through the aquifer tests. The pump will be installed above the well screen, if possible, to prevent cavitation or encrustation of the well screen adjacent to the pump intake. The use of low carbon galvanized steel and stainless steel components as well as retrofitting the NBR components with Teflon components will increase the operational life expectancy of the system.

SP 6-10

PERFORMANCE CURVE

DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH	APPROX. UNIT SHIPPING WT. (LBS.)
SP6-10	2	38¾"	60

NOM. FLOW RATE - 30 GPM
FLOW RANGE - 20 to 40 GPM.
PUMP OUTLET - 2" NPT

Figure 4 Pump Specifications for Drift and Platteville Source Control Wells

Aquifer Test Plan

The RAP requires that aquifer tests be conducted at the Drift and Platteville source control wells. The source control well pump tests will be performed in accordance with ERT Standard Operating Procedure Number 7730, Aquifer Test and Data Evaluation (Appendix C) as modified in this plan. Where there are differences between procedures described in Appendix C and this Site Management Plan, the Site Management Plan will have priority. Parameters to be ascertained during the aquifer tests include local hydraulic conductivity and storativity of both the Drift and the Platteville Aquifers.

Figure 5 shows the proposed location of the Drift source control well and the locations of potential observation wells screened in the Drift aquifer. Drawdowns during the Drift aquifer test can be estimated using analysis by Neuman (1975). The analysis incorporates the following assumptions:

- fully penetrating wells with no storage capacity;
- uniformly porous unconfined aquifer underlain by an aquiclude;
- homogeneous, anisotropic aquifer of infinite extent and constant thickness; and
- drawdown negligible with respect to saturated thickness.

Based on a horizontal hydraulic conductivity of 1030 gpd/ft^2, aquifer thickness of 65 feet, storage coefficient of 0.0001, specific yield of 0.1, ratio of vertical to horizontal conductivity of 0.1, and discharge rate of 200 gpm, one foot of drawdown is expected at Drift wells 300 feet from the pumping

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Neuman, S.P. 1975. Analysis of Pump Test Data from Anisotropic Unconfined Aquifers Considering Delayed Gravity Response. Water Resources Research. Vol. 11, No. 2.

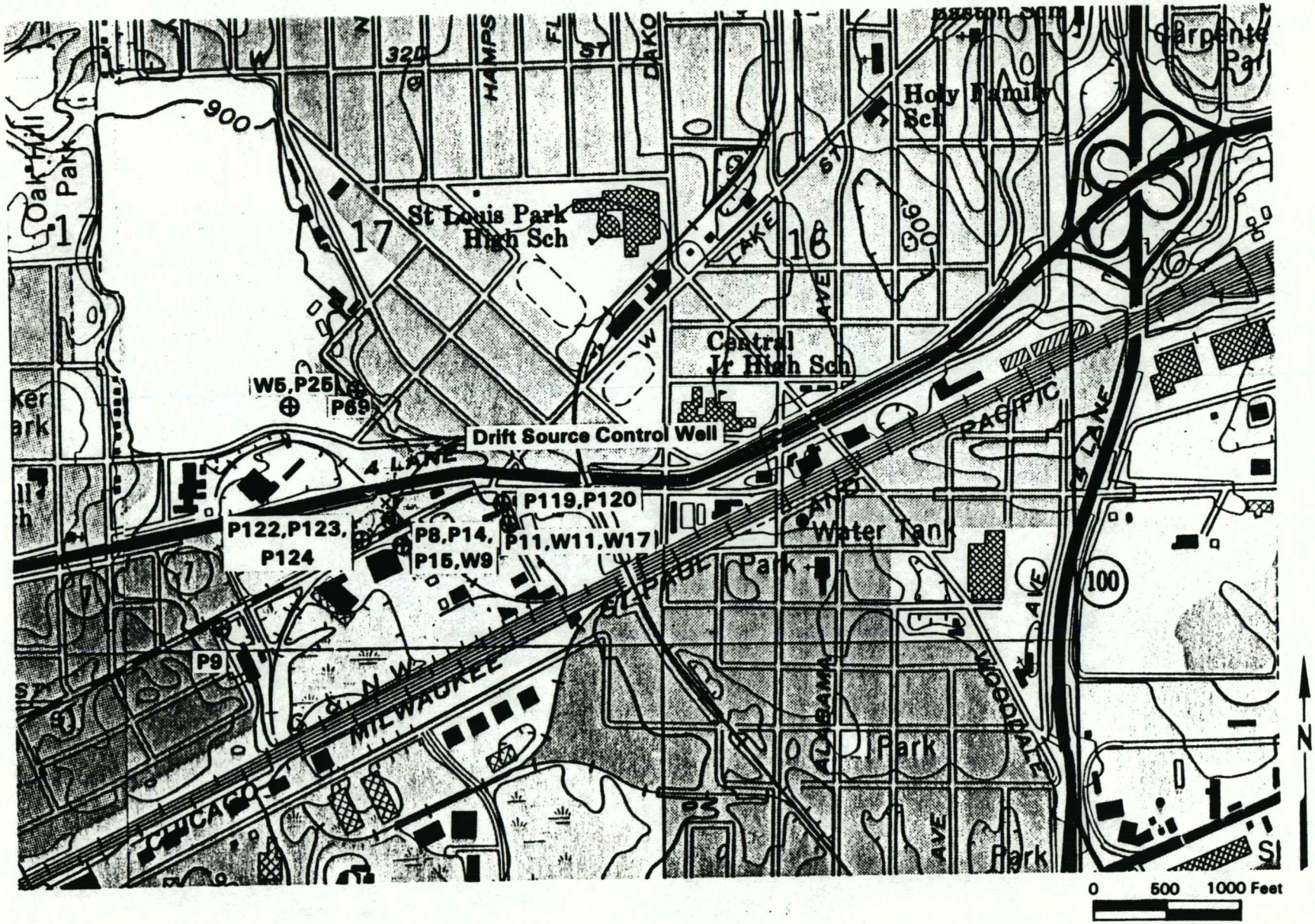


Figure 5 Locations of Potential Monitoring Wells Near Drift Control Well

Drift source control well. (Hydraulic conductivity is estimated based on previous aquifer tests in the area while other parameters are based on typical literature values for glacial drift). Measurable drawdowns are expected at Drift monitoring wells within 1000 feet of the proposed Drift source control well. Potential monitoring wells include P8 and associated wells at 170 feet, P122 and associated piezometers at 220 feet, P119 and P120 at 800 feet, P11 and associated wells at 850 feet, P69 at 900 feet, and W5 and P25 at 1050 feet. At least one of the observation wells will be within 200 feet of the pumping well (P8, P122, or other potentially available wells). At least one other observation well will be P11, P69, W5, P25 or other potentially available wells within about 1000 feet of the pumping well.

Figure 6 shows the proposed location of the Platteville source control well and the locations of several potential observation wells screened in the Platteville aquifer. Drawdowns during the Platteville aquifer test can be estimated using an analysis developed by Theis (1935)*. The analysis incorporates the following assumptions:

- fully penetrating wells with no storage capacity;
- uniformly porous confined aquifer overlain and underlain by aquicludes; and
- homogeneous, anisotropic aquifer of infinite extent and constant thickness.

Based on a transmissivity of 23,000 gpd/ft, storage coefficient of 0.0001, and pumping rate of 60 gpm, drawdown will exceed one foot within 2,000 feet of the pumping Platteville source control well. (Hydraulic conductivity is estimated based on

*Theis, C.V. 1935. The Relation Between the Lowering of Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground-Water Storage. Transactions of the American Geophysical Union, 16th Annual Meeting, Part 2.

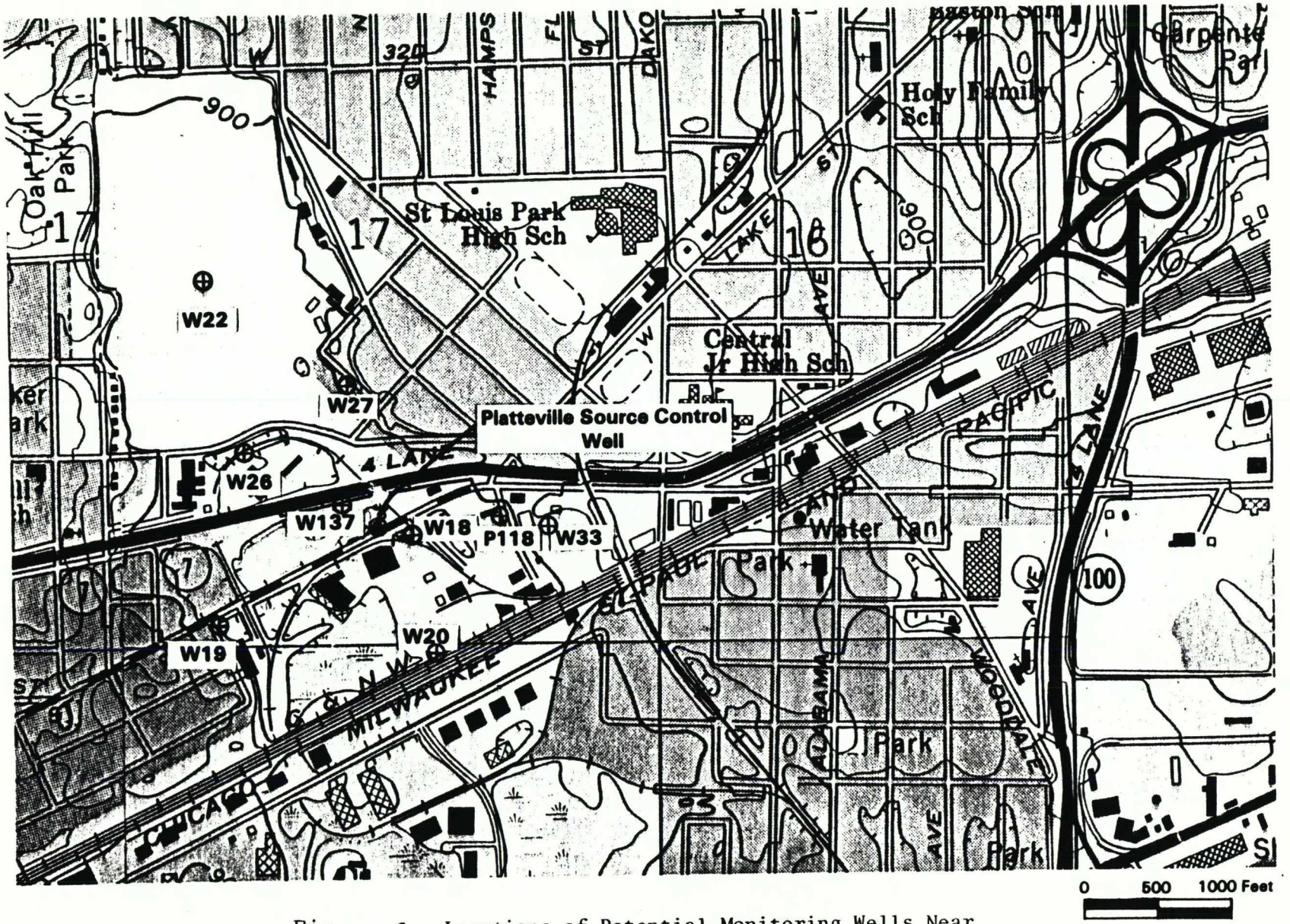


Figure 6 Locations of Potential Monitoring Wells Near Platteville Source Control Well

previous aquifer tests in the area, while other parameters are based on typical literature values for the Platteville formation). Potential monitoring wells include W18 at 250 feet, W137 at 300 feet, P118 at 900 feet, W27 at 950 feet, W20 at 950 feet, W26 at 1050 feet, W19 at 1250 feet, and W22 at 2100 feet. At least one of the observation wells will be within 300 feet of the pumping well (W18 or W137). At least one other observation well will be P118, W27, W20, W26 or W19 at about 1000 feet from the pumping well.

Prior to the aquifer tests potential observation wells must be located and examined. The integrity of the wells will be checked to ensure that they have not been permanently sealed, damaged, or destroyed. In addition, a brief slug test will be performed at each potential observation well to demonstrate the well's response to hydraulic stress. One well volume will be removed from each potential observation well. Wells that do not recover to ninety percent of their original water level within five minutes will be eliminated as potential observation wells. A minimum of two observation wells will be used in both the Drift and Platteville aquifers tests as specified in the Remedial Action Plan. Therefore, if, following inspection and the slug tests, there are fewer than two satisfactory observation wells in each aquifer, it will be necessary to install additional wells to satisfy the RAP. If additional observation wells are required, their construction will be consistent with the conceptual design presented in Figure 7. Given the large number of potential observation wells in the vicinity of the Drift and Platteville source control wells, it is unlikely that construction of additional observation wells will be required. The selection of observation wells (and installation of additional observation wells -- if required) will be subject to review by the EPA and MPCA Project Leaders in accordance with Part O of the Consent Decree and consistent with Section 9.1.1 of the RAP.

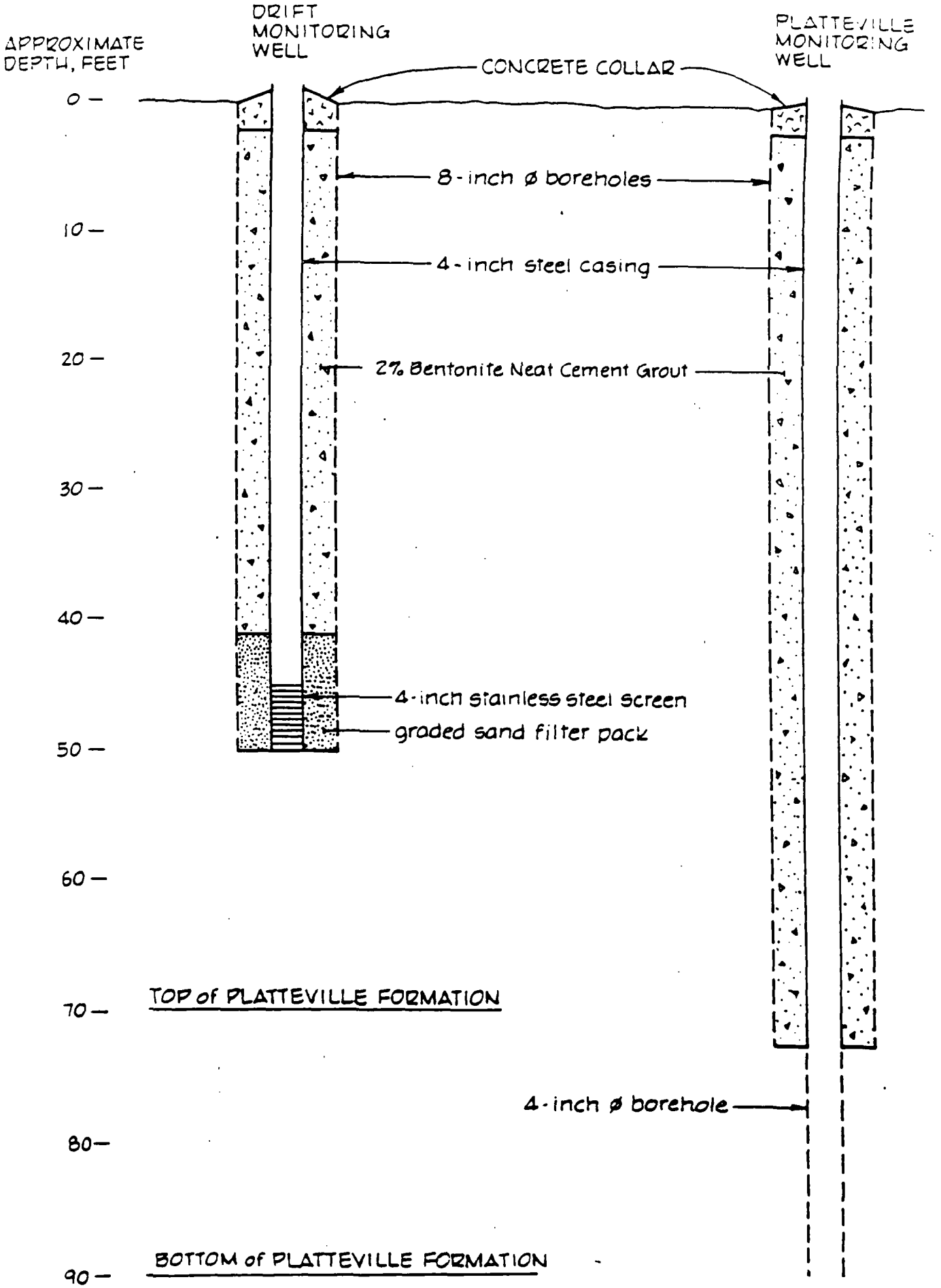


Figure 7 Conceptual Design of Observation Wells

In addition, water level measurements will be collected at a distant well (beyond the pumping well cone of influence) in order to identify extraneous influences. The use of a distant well will allow correction of observed drawdowns in the event of precipitation during the aquifer tests. If possible, the aquifer tests will be conducted during non-rain events.

An In-Situ SE-200 Hydrologic Analysis System or equivalent will be used in conjunction with pressure transducers to log water level data at the pumping wells and at the observation wells. Use of a computerized data logging system will allow accurate collection of early-time measurements during both the pumping and the recovery phases of the aquifer tests. Throughout the aquifer tests atmospheric pressure will be recorded so that water levels can be adjusted for changes due to barometric trends.

During the Drift aquifer test, the Drift source control well will be pumped at the rate of 200 gallons per minute (gpm). During the Platteville aquifer test the Platteville source control well will be pumped at the rate of 60 gpm. Discharge will be conveyed to the nearest sanitary or storm sewer. Appropriate permits for discharge will be obtained prior to commencing the test. The well head and the discharge line will be equipped with an In-Situ flowmeter and flow control valve (diaphragm-type with actuator) connected to the SE-200 Data Unit. This equipment will automatically measure and control the discharge rate.

Each aquifer test will consist of three phases: an initial phase to determine antecedent trends, a pumping phase, and a recovery phase. During the initial phase water levels will be recorded each hour for 48 hours prior to pumping. The pumping phase will last approximately 24 hours for the Platteville source control well, and 72 hours for the Drift source control well. The exact duration of each pumping phase will be determined based on data collected during the test. When water levels have stabilized to within 0.05 feet in 24

hours relative to background, the pumping phase will be terminated. Water levels will be recorded every 10 seconds through the first two minutes, every 30 seconds through the first five minutes, every minute through the first ten minutes, every 5 minutes through the first hour, every 15 minutes through the third hour, every 30 minutes through the fifth hour, every hour through the first day, and every four hours until the end of the pumping phase. Water levels will then be recorded during the recovery phase which will continue until water levels have stabilized near pre-test conditions. The monitoring frequency schedule during recovery will be the same as that followed during the pumping phase (every 10 seconds through the first two minutes, every 30 seconds the first five minutes, every minute the first 10 minutes, every 5 minutes the first hour, every 15 minutes through the third hour, every 30 minutes through the fifth hour, every hour through the first day, and every 4 hours until the end of the test).

Pumphouse Design and Construction

The Drift and Platteville source control wells will be located sufficiently close together (approximately 7 feet) that a single pumphouse can be used to house them both. This will make maintenance and inspection easier. The pumphouse will be located on property owned by the City of St. Louis Park.

The design of the pumphouse for the Drift-Platteville source control wells is based on providing a structure and equipment suitable for what is assumed to be a long-term operation (possibly decades) with minimal maintenance and operating requirements. The pumphouse is designed as a 7'4" by 14'8" walk-in building with plenty of room for maintenance work. The roof is provided with a removable panel to allow for access to the well by a drill rig.

The pumphouse will be a solidly-built masonary structure with a concrete floor. The wall structure will be masonry block with a brick veneer (color to be specified by the City of St. Louis Park) to make a more attractive building. Insulation will be provided in the roof and walls and under the floor for energy efficiency. A concrete driveway off Lake Street is included to provide access and off-street parking for inspection and maintenance personnel. Electric heating and lighting and a floor drain will be provided inside the pumphouse. The floor drain will discharge via a gravity line to an existing sanitary sewer manhole on Lake Street.

The pumphouse foundation will be supported on six tapered wood pilings driven to a depth of about 36 below existing grade. Pilings are required because of the 20-foot-thick layer of peat and organic till underlying the site. The piling design and related soils testing work were performed for Reilly by a local geotechnical engineering firm.

Complete construction specifications and blueprints for the Drift-Platteville source control wells pumphouse are presented in Appendix D. These specifications will be used in obtaining bids and contracting for the construction work.

The pumphouse floor grade will be about 4 feet above the existing grade so as to provide drainage away from the building and meet local requirements for building within a 100-year floodplain.

Piping Design and Construction

The piping design for the Drift and Platteville source control wells is also based on providing for long-term, low-maintenance operation. Galvanized pipe will be used from the wellheads to a point just outside the pumphouse, where carbon steel pipe wrapped with polyurethane insulation and a polyethylene jacket will be used for the underground run to the sanitary sewer. The discharge lines inside the pumphouse will each be provided with a wellhead pressure gauge, followed by a shut-off valve, a flow controller, a flow meter, a reduced pressure backflow preventer, a sample tap, a downstream pressure gauge, and a check valve. The flow meter will signal a combined circular chart

recorder/totalizer. The discharge from the Drift and Platteville source control wells will be under pressure to an existing sanitary sewer manhole on Lake Street.

Complete construction specifications and blueprints for the Drift-Platteville source control piping and sanitary sewer connection are also presented in Appendix D.

Contingent Actions for Contaminated Soils

It is possible that soils contaminated with coal tar materials will be encountered during the excavation required for the Drift-Platteville source control wells pumphouse foundation and/or underground discharge piping. It is likely, however, that any contaminated soils will be thoroughly weathered -- given the site's long history and the relatively shallow excavation depths (4 to 6 feet). Hence, it is unlikely that volatile or "runny" coal tar waste or contamination will be encountered.

If any coal tar wastes or contaminated soils are encountered during excavation work, Reilly's Project Manager, Engineering Manager or Hydrogeology Project Manager/Field Coordinator (see Section B -- Quality Assurance Project Plan) will determine if the material is suitable for use as backfill based on the following visual determination:

> Excavated material containing creosote or coal tar constituents may be used as backfill material if neither the creosote nor coal tar constituents have undertaken a cementatious nature so as to artificially bond the

excavated soil structure as a concrete unit. In the event that creosote or coal tar constituents are encountered in a definable homogeneous mass of excessive concentration or amount sufficient to preclude heterogeneous mixing with undisturbed earthen materials, the creosote or coal tar materials will be classified as unsuitable for backfill material.

Any contaminated materials suitable for and used as backfill will be covered with at least twelve inches of clean fill before final grading (see RAP Section 11.5.3(A)(5)). Any contaminated soils that are unsuitable for backfilling will be temporarily stockpiled at the construction site until all of the excavation work required is completed. (Any existing temporary stockpile at the W23/W105 construction site may also be used). The stockpiled material will then be disposed of off-site in accordance with all applicable state and federal hazardous and solid waste regulations at a RCRA TSD facility.

Any temporary stockpile of contaminated soils for off-site disposal will be covered with plastic sheeting at the end of each work day. The cover sheeting will also be disposed of off-site -- in accordance with all applicable rules and regulations -- after the stockpiled soils are removed for disposal. Any temporary stockpile should be in active use for no more than 30 days, given the detailed construction schedule presented later. In any event, any temporary stockpile will be removed no more than 90 days after it was started and cause no imminent or actual endangerment to the public health or the environment.

The Health and Safety Plan for this work (see Section C) recognizes that coal tar contamination may be encountered during excavation work and specifies appropriate measures for worker-protection if contamination is encountered.

Operation and Monitoring

Pumping of the Drift and Platteville source control wells will begin within 10 days of receiving approval of the construction from the EPA and MPCA Project Leaders. Each well will be pumped at a monthly average rate of 25 gpm, as specified by RAP Section 9.1.3, until a request to cease pumping is approved pursuant to RAP Section 9.1.4. Reilly will notify the EPA and MPCA when the Drift-Platteville source control well construction is completed and ready for their inspection and approval. Further details on the inspection, approval and start-up process are provided in Section 6.0 of the Quality Assurance Project Plan (Section B).

The Drift-Platteville source control wells will be operated by the City of St. Louis Park (the City) on behalf of Reilly Tar & Chemical Corporation (Reilly) in accordance with the Reilly/City Agreement (Exhibit B to the Consent Decree) beginning on the day that pumping is started. The City will inspect the pump operation at least twice per week for each well. All inspections will be noted in a log book using a form like the one shown in Figure 8. The flow meter totalizer readings, date, time, inspector's name, and any relevant comments will be recorded

FIGURE 8

INSPECTION LOG FOR THE DRIFT-PLATTEVILLE SOURCE CONTROL WELLS

Date	Time	Drift Source Control Well			Platteville Source Control Well			Inspector's Name
		Flow Totalizer Reading (gal)	Calculated Average Flow Rate (gpm) For Month-to-Date	Comments	Flow Totalizer Reading (gal)	Calculated Average Flow Rate (gpm) For Month-to-Date	Comments	

in the log during each inspection. The log book will be kept at the pumphouse, with a backup copy kept at City Hall. The log book and circular recorder charts will be maintained as permanent records by the City in accordance with applicable state and local statutues. The EPA and MPCA will be notified by the City before any of these records are destroyed.

The Drift-Platteville source control wells will be pumped continuously, except for brief shut-down periods required for maintenance and/or repair. The City will notify the EPA and MPCA Project Leaders of any shutdown lasting more than three working days, with an explanation of the cause and an estimated date when pumping will be restarted. Shut-down periods for maintenance or repair are expected to be brief and infrequent because of the simple equipment involved.

The Drift and Platteville source control wells will normally each be pumped at a rate of 25 gpm, but this rate will be increased as required after shut-down periods in order to maintain a monthly average rate of 25 gpm. The monthly average rate will be calculated on a calendar month basis using the flow totalizer readings in the inspection log. Average flow rates for the month-to-date will be calculated and noted in the log book at least once a week to help ensure that the 25 gpm monthly average rate will be met each month. The circular charts from the flow recorder will not be used to determine compliance with the 25 gpm monthly average rate requirement, because the totalizer gives more accurate readings. The circular charts are intended to document any variations in flow rate and any shut-down periods.

Monthly average pumping rates for the Drift-Platteville source control wells will be reported for the applicable calendar months in the progress reports required by Part K of the Consent Decree. In addition, the City will provide copies of the log book and circular charts to the EPA and MPCA Project Leaders on a monthly basis during the first year of operation.

Control of the well discharge rate will be accomplished using both the flow controller and the recorder/totalizer. The desired flow rate can be set initially by the scale on the flow controller. Over a period of hours or days, the totalizer readings can be used to check the flow rate and the initial controller setting adjusted accordingly. Once routine operation is established, the totalizer readings and times noted in the log book -- or the circular chart recorder reading -- can be used to check the flow rate and the flow controller setting adjusted as necessary.

The discharge from the Drift-Platteville source control wells will be monitored quarterly for Carcinogenic PAH, Other PAH and Phenolics, as specified by RAP Section 9.1.3. The monitoring will be performed by the City in accordance with the Reilly/City Agreement. In addition, Reilly will monitor the discharge from each well for Carcinogenic PAH, Other PAH and Phenolics once during the first week of pumping. This initial monitoring is not required by the RAP, but is suggested by Reilly to aid in time-series analysis of the Drift-Platteville source control wells monitoring data. Sampling and analysis for this initial monitoring will be conducted by ERT using the procedures specified in the "Initial

Sampling Plan for the Reilly Tar & Chemical Corp. NPL Site - St. Louis Park, Minnesota" (submitted to the EPA and MPCA by the City on October 3, 1986 pursuant to RAP Sections 3.2 and 3.3) as approved by the EPA and MPCA.

It should be noted that Section 2(c) of the Reilly/City Agreement requires that the discharge from Drift-Platteville source control wells will be routed to the storm sewer before the fourth anniversary of the Effective Date of the Consent Decree. This change may require pretreatment of the discharge, depending on the NPDES effluent limitations established pursuant to RAP Section 2.5. Discontinuance of the discharge to the sanitary sewer will be implemented in accordance with RAP Section 2.9.

Construction Report

Pursuant to Section 9.1.2 of the RAP, Reilly will prepare a report which presents the installation logs for the Drift and Platteville source control wells, the results of the Drift and Platteville aquifer tests, and descriptions of any field adjustments to the approved design. The report will be submitted to the EPA and MPCA within the 120-day construction period specified by the RAP.

Construction Schedule

Section 9.1.2 of the RAP specifies that construction of the Drift and Platteville source control wells must be completed "within 120 Days of receiving all necessary permits and approval of Äthisü plan, . . . whichever occurs last." The 120-day period allowed should be adequate for the required construction work if no major unexpected difficulties are encountered. The construction report will also be submitted within this 120-day period.

Figure 9 presents the detailed construction schedule currently planned for the Drift-Platteville source control well work. This schedule is subject to modification as the work progresses, and Reilly makes no commitments to meeting any of the schedule dates other than the 120-day completion requirement specified in the RAP (subject to any extensions requested and granted in accordance with the Consent Decree). The schedule in Figure 9 is provided solely to assist the EPA, MPCA and City in planning inspections of the work. The Project Leaders for these entities will be provided with an updated schedule before beginning any on-site work and as required by any major schedule changes after the work has started.

Figure 9 indicates a total schedule of 57 working days for completing the Drift and Platteville source control construction. This amounts to 79 calendar days if work is started on a Monday or Tuesday with a five-day work week. This schedule provides considerable flexibility relative to the 120-day period specified by the RAP.

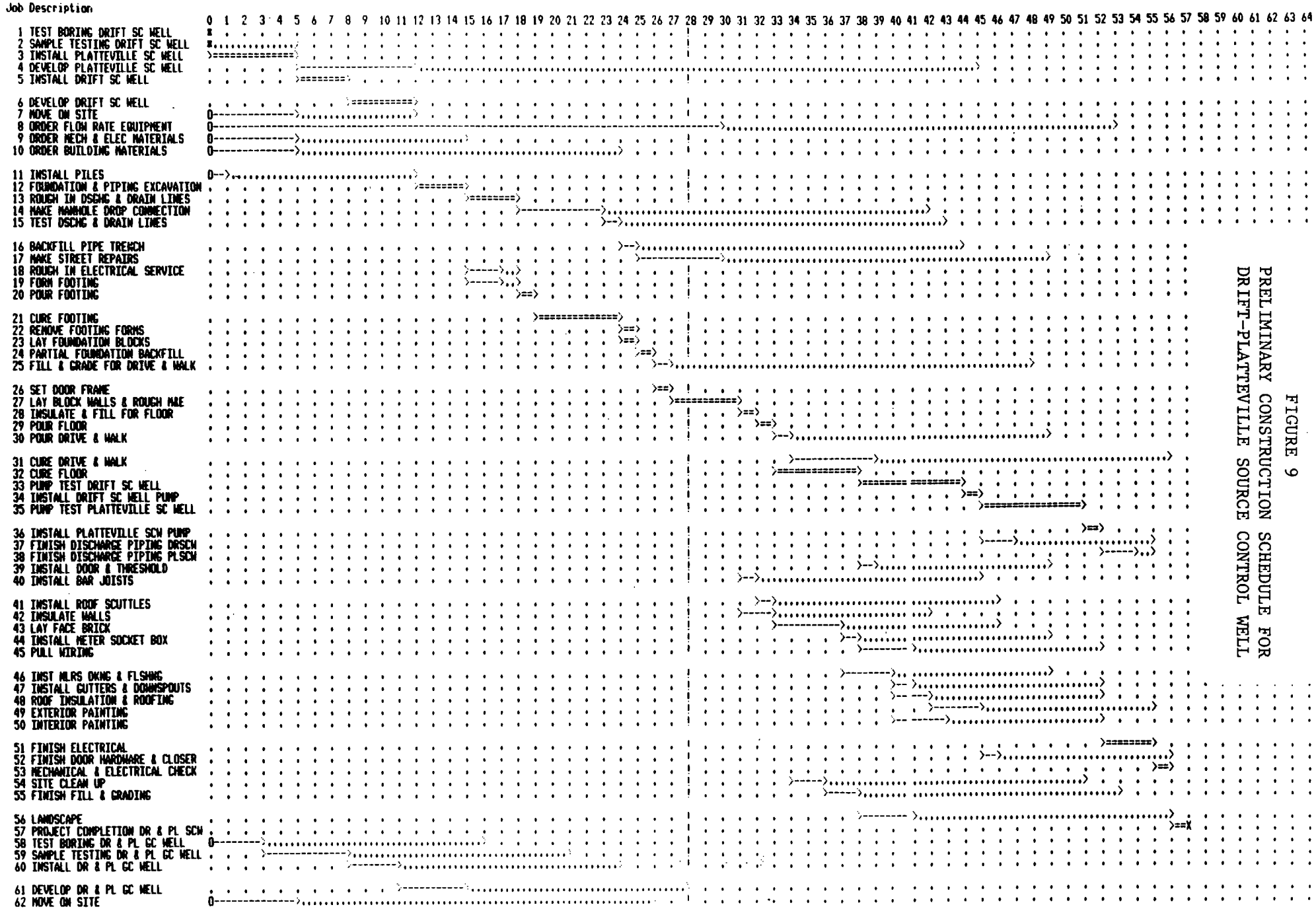
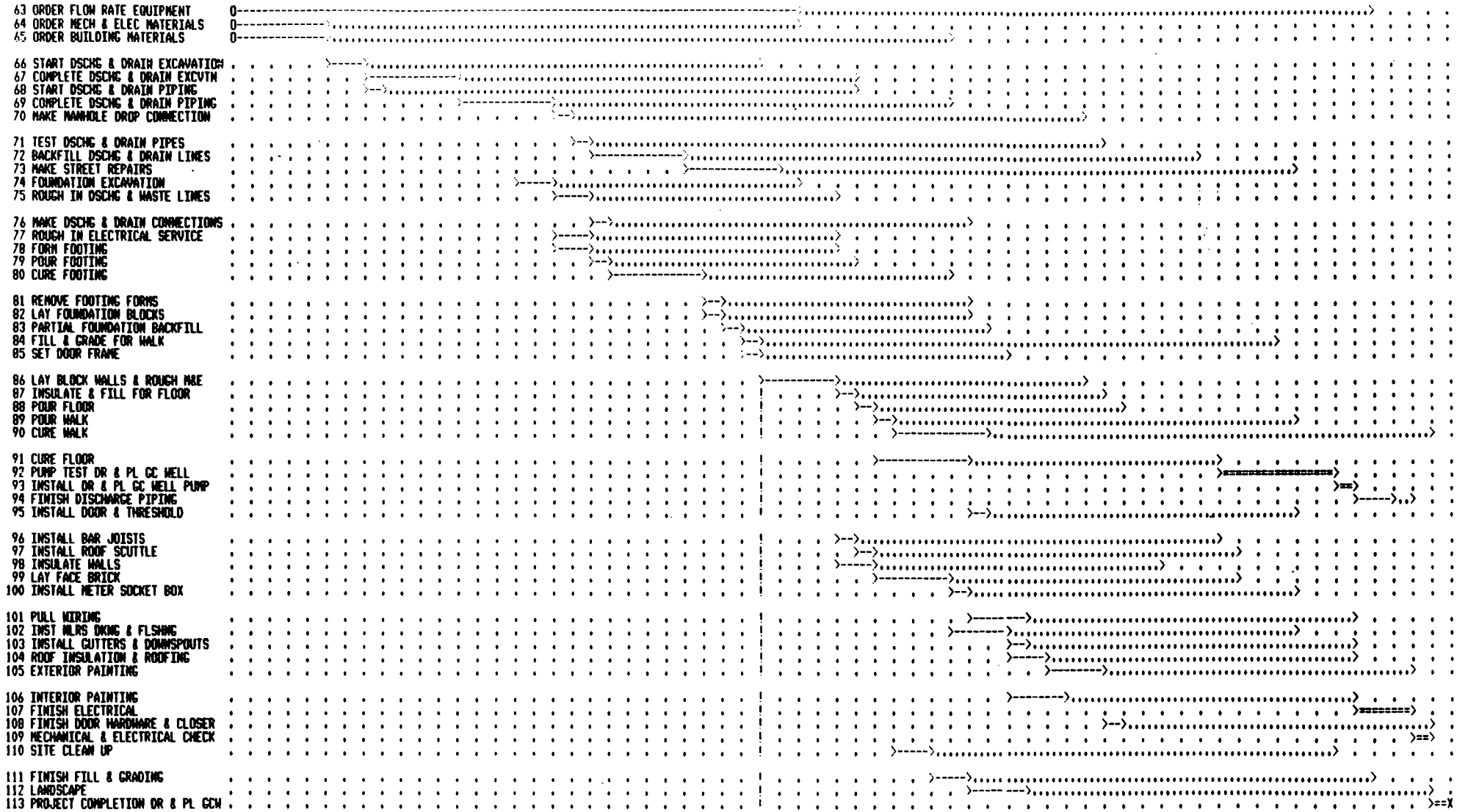


FIGURE 9

PRELIMINARY CONSTRUCTION SCHEDULE FOR DRIFT-PLATTEVILLE SOURCE CONTROL WELL



SORTING ORDER IS CURRENT ORDER
FROM THE FIRST JOB TO THE LAST JOB
JOBS USING ALL SKILLS

Symbol-Explanation
>--> Duration of a normal job
:..> Slack time for a normal job
>==> Duration of a critical path job
>::> Duration of a completed job
x Job with zero duration
+ Job deadline
0--> Job with no prerequisites
>--X Job with no successors
! Time break due to holiday or week-off

FIGURE 9
(CONT'D)

The schedule in Figure 9 assumes that the work at the Drift-Platteville source control wells will proceed simultaneously with that at the Drift gradient control well. This will simplify the mobilization and logistics for installing the three wells and conducting the three aquifer pump tests. While this simultaneous approach is not required to meet the 120-day construction deadline, it would be helpful if all plan and permit approvals required for the Drift gradient control and Drift-Platteville source control wells could be granted simultaneously.

As indicated above, Section 9.1.2 of the RAP specifies that the 120-day construction period starts when Reilly receives approval of this plan and receives all necessary permits, whichever occurs last. Reilly is required to obtain various permits from the City as well as the DNR and MWCC permits specified in RAP Section 9.1.1. In order to comply with Part T of the Consent Decree (Other Applicable Laws), the EPA and MPCA have agreed to make their approval of this plan effective upon the day that the City issues the required permits, provided that this occurs within 60 Days of Reilly's receipt of the approval letter. Reilly will submit the required City permit applications promptly after receiving approval of this plan from the EPA and MPCA, and will provide copies of the City permit applications to these agencies. Reilly will notify the EPA and MPCA by certified mail promptly after receiving the last of all required City, DNR and MWCC permits, and the 120-day construction period will begin on the day that Reilly receives the last required permit.

SECTION B
QUALITY ASSURANCE PROJECT PLAN

QUALITY ASSURANCE PROJECT PLAN
FOR DRIFT-PLATTEVILLE AQUIFER SOURCE CONTROL WELLS AT THE RTCC - ST. LOUIS PARK SITE

ERT Document No. QAD722-291

October 1986

Amended January 1987

Prepared for

REILLY TAR & CHEMICAL CORPORATION
INDIANAPOLIS, INDIANA

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1.0 INTRODUCTION

1.1 Background

ERT and the Reilly Tar & Chemical Corporation (RTCC) will complete certain tasks in fulfillment of the Consent Decree and Remedial Action Plan (RAP) for the St. Louis Park Site. This Quality Assurance Project Plan pertains to all work to be performed by ERT, RTCC and subcontractors in completing the requirements of Section 9.1 of the RAP. Section 9.1 concerns source control actions in the Drift-Platteville Aquifer in the vicinity of the St. Louis Park Site. This work will involve the installation of two source control wells at depths of about 65 and 90 feet, installation of pumps; and conducting pumping tests in accordance with ERT SOP 7730, Aquifer Test and Data Evaluation (see Appendix). Further details on the work to be performed, its purpose and the methodology to be employed may be found in the project Site Management Plan.

1.2 Quality Objectives

The purpose of this Quality Assurance Project Plan is to define the Quality Assurance and Quality Control provisions to be implemented to ensure that:

- The resulting source control wells conform to design specifications given in the project Site Management Plan.

- The work is performed in an efficient manner.
- Field records generated during the course of the field work are sufficiently complete and accurate to satisfy data analysis and report requirements.
- All assumptions, formulae, interpretations and numerical analyses used in the process of deriving reported results and conclusions are documented in permanent records.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project organization is illustrated in Figure 2-1. The RTCC Project Manager, Mr. John Craun will oversee and coordinate all project activities. The ERT Project Manager/Field Coordinator, Mr. William Gregg, will schedule and direct all field activities, including the design and implementation of the aquifer tests, and will conduct correspondence with RTCC. The ERT Project Manager/Field Coordinator is also responsible for maintaining records of the work performed on the project and for archiving those records in the Central File upon completion of the work. The RTCC Engineering Manager, Mr. Lewis Locke will direct the engineering aspects of the work, including the installation of the sewer line connections and pump houses. The Project Quality Assurance Officers are responsible for ensuring that this plan is implemented by their respective organizations, and that project data undergo technical and peer review, as necessary. The pump installation contractor will perform all work necessary to install the pumps and make them operational. The sewer

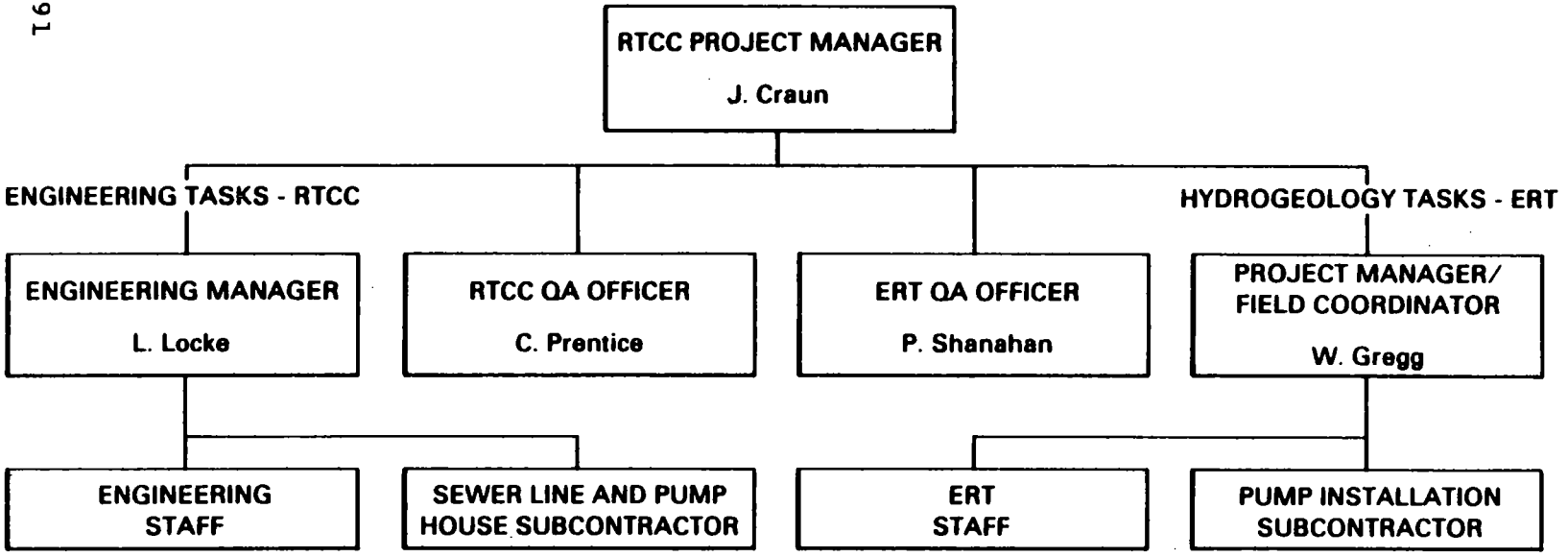

Figure 2-1 Project Organization

line connection subcontractor will install piping and connections to the sewer lines and will install well houses to enclose the wells and pumps.

3.0 QA/QC - FIELD ACTIVITIES

3.1 Training

In order to ensure that the two subcontractors doing the field work can do so in a cooperative and efficient manner, instruction and guidance will be provided by the RTCC Project Manager and the ERT Project Manager/Field Coordinator to instill an understanding of the project objectives and plans and of the respective roles of the subcontractors.

3.2 Subcontractor Quality Control

Subcontractor quality control is that system of activities which ensures that products or services obtained from subcontractors fulfill the needs of the project. Subcontractor quality control begins with subcontractor procurement. The project policy for control of procurement is described in the ERT Quality Assurance Manual for Hazardous Waste Site Investigations, Chapter 5. The subcontractor procurement process considers:

- Bidder's qualifications in terms of personnel and physical resources, Quality Assurance program and Health and Safety program,

- Results of pre-qualification audits, if appropriate,
- Price and technical qualifications

Periodic quality control inspections of each contractor will be performed by the RTCC Engineering Manager and the ERT Project Manager/Field Coordinator to evaluate adherence to the QA Project Plan and the project Health and Safety Plan. Inspection will include (as appropriate):

- Type and condition of equipment,
- Calibration procedures,
- Personnel qualifications,
- Decontamination procedures,
- Documentation.

Results of the inspection will be entered in the field notebook.

3.3 Document Control and Recordkeeping

Document Control for the Drift-Platteville Aquifer Source Control Well work serves a two-fold purpose. It is a formal system of activities that ensures that:

1) All participants in the project are promptly informed of revisions of the Quality Assurance Project Plan; and
2) All critical documents generated during the course of the work are accounted for during, and at the end of the project.

This QA Project Plan and all Standard Operating Procedure documents have the following information on each page:

- Document Number
- Page Number
- Total number of pages in document
- Revision number
- Revision date

When any of these documents are revised, the affected pages are reissued to all personnel listed as document holders with updated revision numbers and dates. Issuance of revisions is accompanied by explicit instructions as to which documents or portions of documents have become obsolete.

Control of, and accounting for documents generated during the course of the project is achieved by assigning the responsibility for document issuance and archiving. For the Drift-Platteville Aquifer Source Control Well work, the RTCC Project Manager and the ERT Project Manager/Field Coordinator have this responsibility.

Documentation for the project will either be recorded in non-erasable ink, or will be photocopied promptly upon completion, and the photocopies dated. All documents will be signed by the person completing them.

4.0 AQUIFER TEST

The aquifer tests will be performed in accordance with ERT SOP No. 7730, Aquifer Test and Data Evaluation, and the project Site Management Plan.

5.0 NUMERICAL ANALYSIS AND PEER REVIEW

All numerical analyses, including manual calculations, mapping, and computer modeling will be documented and subjected to quality control review in accordance with ERT SOP 2005, Numerical Analysis and Peer Review. All records of numerical analyses will be legible, reproduction-quality and complete enough to permit logical reconstruction by a qualified individual other than the originator.

6.0 AUDITS AND CORRECTIVE ACTION

ERT conducts periodic audits to assess the level of adherence to QA policies, procedures and plans.

Whenever quality deficiencies are observed that warrant immediate attention, formal corrective action request forms are issued to the project manager by the Quality Assurance Department. The QA Department retains one copy of the form when it is issued. The project manager completes the form and signs it when corrective action has been implemented, and returns the original to the QA Officer to close the loop.

The Quality Assurance Department maintains a record of all corrective action requests and reports their status to ERT management in a quarterly report.

Should an audit be conducted on the Drift-Platteville Source Control Well work activities, RTCC will be apprised of the audit findings and of any corrective action that is requested and performed.

7.0 CONSTRUCTION APPROVAL

The Reilly Project Leader (or Alternate) will provide written notification to the U.S. EPA, MPCA and City Project Leaders within 3 days of completing construction of the Drift-Platteville source control well system. Following receipt of such notification, the U.S. EPA, MPCA and City Project Leaders (or their designees) will inspect the system and Reilly will demonstrate that the system has been constructed and operates in accordance with the approved Drift-Platteville source control well plan. Following their inspection of the system, the U.S. EPA and MPCA Project Leaders (or Alternates) will notify the Reilly Project Leader in writing as to whether the Drift-Platteville source control well system is approved or disapproved. In the event that the system is approved, the City will commence operation of the system within 5 days of Reilly's receipt of the approval letter. In the event that the system is disapproved, the U.S. EPA and MPCA Project Leaders will explain in writing the basis for the disapproval and the items that need to be corrected, and Reilly will either correct the items or explain in

writing why the system should be approved as constructed. If corrections are made, the notification, inspection, and approval/disapproval sequence described above will be repeated.

The U.S. EPA, MPCA, City and Reilly recognize that the inspection and approval procedure described above represents procedures beyond those required by Section 9.1 of the RAP. The U.S. EPA and MPCA therefore agree that, with respect to the provisions of Part M of the Consent Decree, Reilly will be deemed to have met the schedule requirements specified in Section 9.1 of the RAP if the Reilly Project Leader provides notice that the Drift-Platteville source control well construction is complete within 60 days of the start of the construction period and if the City commences operation of the Drift-Platteville source control well system within 5 days of Reilly's receipt of approval of the construction.

Notwithstanding the procedures described above, the City, U.S. EPA, MPCA and Reilly reserve all of their rights under the Consent Decree for dispute resolution, extension requests and related actions with respect to the construction, inspection, approval and operation of the Drift-Platteville source control well system.

SECTION C
HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

for the

Reilly Tar & Chemical Corporation
St. Louis Park, Minnesota Site
Drift-Platteville Source Control Well Construction

Project Number: D722-295

Division Number: 120

Date: January 2, 1987

Prepared By: Kevin Powers

Date: January 2, 1987

Approved By: John Cramer for Peter Shanahan

Date: 1/28/87

Kevin Powers
Health & Safety Manager

Date: 1/27/87

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HEALTH AND SAFETY PLAN

1.0 Introduction

This health and safety plan applies to on-site personnel who will potentially be exposed to soil and/or groundwater contamination during the construction of the Drift-Platteville source control wells near the Reilly Tar & Chemical Corporation, St. Louis Park site. This plan has been designed to comply with, as a minimum, the requirements set forth in 29 CFR 1910.120, the OSHA standards governing hazardous waste operations. The ERT Project Manager and project staff will be responsible for continuous adherence to the safety procedures during site work at St. Louis Park. In no case may work be performed in a manner that conflicts with the intent of or the safety concerns expressed in this plan. Other contractors and subcontractors involved in this project will be required to adhere to this safety plan, as a minimum, and to conduct all work in accordance with applicable health and safety regulations, including 29 CFR 1910.120.

2.0 Site Description and History

Reilly Tar & Chemical Corporation (RTCC) operated a creosote wood preserving plant and coal tar refinery in St. Louis Park, Minnesota from 1917 to 1972. In 1972 the plant site was sold to the City of St. Louis Park and the plant was removed. The 80-acre site was subsequently converted to a variety of productive uses, including an apartment complex, some commercial buildings, a new roadway and a large open park. Contamination by creosote and coal tar-related materials of soil, shallow ground water and a deep bedrock well have occurred at the site. Also, certain coal tar-related chemicals have been found in portions of deep bedrock aquifers in the St. Louis Park area.

3.0 Scope of Work

Specific work activities at the site will include the installation of two new pumping wells, connection of the well discharges to the sanitary sewer system, and erection of brick-and-block wellhouses. Trenches will be dug from the wellhouses to the sanitary sewer in order to make the discharge connections.

Exposure to the contaminants described below may occur during the performance of these activities.

4.0 Contaminants of Concern and Effects of Overexposure

The contaminants of concern which have been identified at this site are coal tar and creosote related materials including naphthalene, other polynuclear aromatic hydrocarbons (PAH) and phenolic compounds.

Coal tar and creosote are typically irritating to the eyes, skin and respiratory tract. Acute skin contact may cause burning and itching while prolonged contact and poor hygiene practices may produce dermatitis. Prolonged skin contact with creosote must be avoided to prevent the possibility of skin absorption.

Naphthalene is a hemolytic agent which, upon overexposure to the vapor or ingestion of the solid, may produce a variety of symptoms associated with the breakdown of read blood cells. Naphthalene is also irritating to the eyes and repeated or prolonged contact has been associated with the production of cataracts.

Repeated exposure to certain PAH compounds has been associated with the production of cancer. Contact of PAH compounds with the skin may cause photosensitization of the skin producing skin burns after subsequent exposure to ultraviolet radiation.

Phenolics are generally strong irritants which can have a corrosive effect on the skin and can also rapidly penetrate the skin. Overexposure to phenols and phenolic compounds may cause convulsions as well as liver and kidney damage.

5.0 Hazard Assessment

5.1 Initial

Because of the relatively low vapor pressures associated with PAH compounds (generally less than 10^{-4} mm Hg at 20°C), they are not expected to present a vapor hazard at this site. The most likely threat of exposure to these compounds will be via skin contact.

Although naphthalene and phenol also have relatively low vapor pressures (0.05 and 0.36 mm Hg at 20°C, respectively) there is a possibility that these substances may produce vapor hazards at this site under adverse conditions.

5.2 Continuing Hazard Assessment On-Site

Air Monitoring

An HNU Photoionization Detector (PID) equipped with a 10.2 eV lamp will be used to provide semiquantitative data on VOC concentrations in and around the breathing zone of workers. Air sampling will be conducted by taking and recording periodic readings in the breathing zone at each of the following locations:

- In the breathing zone near the opening of each well being drilled.
- In the breathing zone over freshly-exposed soil being excavated.

Action Limits

The American Conference of Governmental Industrial Hygienists (ACGIH) has established threshold limit values (TLV) for phenol and naphthalene at 5 and 10 ppm, respectively, as 8-hour time weighted averages (TWA). Based on these values, the action limits in Table 1 have been set. The lower limit of 5 ppm is based on the TLV for phenol while the upper limit of 50 ppm is based on a minimum protection factor of 10 for a half mask, air purifying respirator.

Response

When the PID yields persistent breathing-zone readings at or above the lower action limit, workers in the affected area will don respirators. Air sampling will continue on a more frequent basis. If readings are persistent at or above the upper limit, workers shall back off from the immediate work area until measured breathing- zone concentrations fall below the lower limit, at which time operations will resume and normal air monitoring will continue. If breathing zone levels do not fall below the upper limit, workers are to leave the work area and report the condition immediately to the Health and Safety Manager. If necessary, engineering controls will be instituted to maintain vapor concentrations below the upper limit or arrangements will be made to upgrade to Level B protection.

6.0 Personal Protective Equipment

Personal protective equipment (PPE) will be donned, as necessary, based on the hazards encountered. Listed below is the personal protective equipment to be utilized during this project and the conditions requiring its use.

TABLE 1

ACTION LIMITS FOR AIR CONTAMINANTS

Limit	Persistent Concentration in the Breathing Zone	Procedure
Lower	5 ppm	Don respirators, step up monitoring.
Upper	50 ppm	Stop work and back off from immediate work area until levels subside in the breathing zone.

Personal Protective Equipment

- Coveralls - Polyethylene coated Tyvek if work involves contact with contaminated soil or ground water.
- Boots - Chemical resistant type if work involves contact with contaminated soil or groundwater.
- Hard Hat - When working in the vicinity of operating heavy machinery (i.e., drilling rig, backhoe, etc.)
- Face shield - If splash hazard exists.
- Gloves - Nitrile for potential contact with contaminated soil or ground water.
- Respirator - MSA Comfo II with GMC-H Cartridges if PID reading exceeds 5 ppm or if dust or odors become objectionable.
- Chemical Safety Goggles - If eye irritation occurs.

Because of the carcinogenicity of certain PAH compounds, and because of the skin hazards associated with PAH and phenolic compounds, it is important that appropriate protective clothing be worn during work activities, such as drilling and excavation, which may involve the possibility of skin contact with contaminated soil or ground water. As a minimum, the presence of visible creosote or coal tar-related material shall constitute evidence of contaminated soil or groundwater.

7.0 Health and Safety Training

Site personnel covered by this health and safety plan must have received appropriate health and safety training prior to their working on the site. Training will include:

- Requirements for ERT employees to have received the baseline medical examination within one year of on-site work.

- Requirements for and use of respirators and personal protective equipment.
- Cautions regarding the potential for trench collapse.
- Required personal hygiene practices.
- Requirements for employees to work in pairs.
- Proper material handling.
- Proper sampling procedures.
- Maintenance of safety equipment.
- Effective response to any emergency.
- Responses to fires and explosions.
- Emergency procedures (e.g., in the event of a trench collapse).
- Hazard zones.
- Decontamination methods.
- General safety precautions.

A copy of the Standard Safety Procedures (Table 2) will be given to each worker covered by this health and safety plan.

8.0 Decontamination

Administrative procedures require hygienic practices consistent with work hazards. Employees will be instructed in the training program on proper personal hygiene procedures.

Contaminated, reuseable PPE, such as boots, hard hats, face shields and goggles, will be decontaminated prior to leaving the site. The decontamination procedure follows.

- Rinse with water to removed gross contamination.
- Wash in Alconox or equivalent detergent solution.
- Rinse with clean water.

Contaminated, disposable PPE, such as Tyvek coveralls and gloves will be placed in 55-gallon drums and stored on site while arrangements are made for disposal.

TABLE 2

STANDARD SAFETY PROCEDURES

RTCC ST. LOUIS PARK SITE

- ERT employees are required to have a baseline medical examination within one year of on-site activity.
- Employees are required to work in pairs.
- Wash face and hands prior to eating, smoking, or leaving the site.
- No smoking or eating is allowed in the work area during active drilling, excavation or sampling activities.
- Wearing of contact lenses is not permitted in the work area.
- Contaminated material (e.g., Tyvek coveralls) must be properly disposed of before leaving the site.
- All work must be conducted in accordance with local, state and federal EPA and OSHA regulations, particularly 29 CFR 1910.120.
- The walls of trenches greater than 4 feet in depth must be sloped back to the angle of repose prior to entering. For average soil, an angle of 45^{o} is recommended.

Respirators, if used, will be cleaned and disinfected after each day of use. The facepiece (with cartridge removed) will be washed in a hypochlorite (or equivalent) disinfecting solution, rinsed in warm water and air dried in a clean place.

9.0 Emergency Procedures

This Health and Safety Plan has been established to allow site operations to be conducted without adverse impacts on worker health and safety as well as public health and safety. In addition, supplementary emergency response procedures have been developed to cover extraordinary conditions at the site.

9.1 General

All accidents and unusual events will be dealt with in a manner to minimize a continued health risk to site workers. In the event that an accident or other unusual event occurs, the following procedure will be followed:

- First aid or other appropriate initial action will be administered by those closest to the accident/event. This assistance will be conducted so that those rendering assistance are not placed in a situation of unacceptable risk. In the event that a worker is caught in a trench collapse, call for emergency assistance immediately.
- All accidents/unusual events must be immediately reported to the ERT Health and Safety Manager, the ERT Project Manager, and the other contacts listed in Table 3.
- All workers on site should conduct themselves in a mature, calm manner in the event of an accident/unusual event, to avoid spreading the danger to themselves, surrounding workers and the community.

9.2 Responses to Specific Situations

Emergency procedures for specific situations are given in the following paragraphs.

Worker Injury

If an employee in a contaminated area is physically injured, Red Cross first-aid procedures will be followed. Depending on the severity of the injury, emergency medical response may be sought. If an excavation collapses and a worker is caught, call for emergency assistance immediately. If the person is in no immediate danger, do not attempt to move him. Internal injuries could be worsened. If the employee can be moved, he will be taken to the edge of the work area (on a stretcher, if needed) where contaminated clothing (if any) will be removed, emergency first-aid administered, and transportation to a local emergency medical facility awaited.

If the injury to the worker is chemical in nature (e.g., overexposure), the following first-aid procedures are to be instituted:

- Eye Exposure - If contaminated solids or liquids get into the eyes, wash eyes immediately using large amounts of water and lifting the lower and upper lid occasionally. Obtain medical attention immediately.
- Skin Exposure - If contaminated solids or liquids get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. Obtain medical attention immediately when exposed to concentrated solids or liquids.
- Inhalation - If a person inhales large amounts of a toxic vapor, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Obtain medical attention as soon as possible.

- Swallowing - When contaminated solids or liquids have been swallowed, the Poison Control Center will be contacted and their recommended procedures followed.

9.3 Notification

Checklist

The names and phone numbers of all personnel and agencies that could be involved in emergency responses have been determined. Table 3 provides the notification checklist for use at the St. Louis Park site.

Documentation

The ERT Project Manager will provide a report to the Health and Safety Manager containing the following information regarding any incidents implicating health and safety concerns:

- The event (including date and time) that necessitated the notification and the basis for that decision.
- Date, time, and names of all persons/agencies notified and their response.
- Resolution of the incident (including duration) and the method/corrective action involved.

This report will be submitted within five working days of the resolution of the event.

TABLE 3

NOTIFICATION CHECKLIST

RTCC, ST. LOUIS PARK SITE

In the event of an extraordinary event that might be damaging to personnel or adjacent property, immediate notification of the proper emergency service will be required. The proper emergency service is determined by the nature of the emergency.

EMERGENCY NOTIFICATION

Fire Department	920-2345
Ambulance	920-2345
Police Department	920-2345
Methodist Hospital	932-5000
Poison Control Center	347-3141

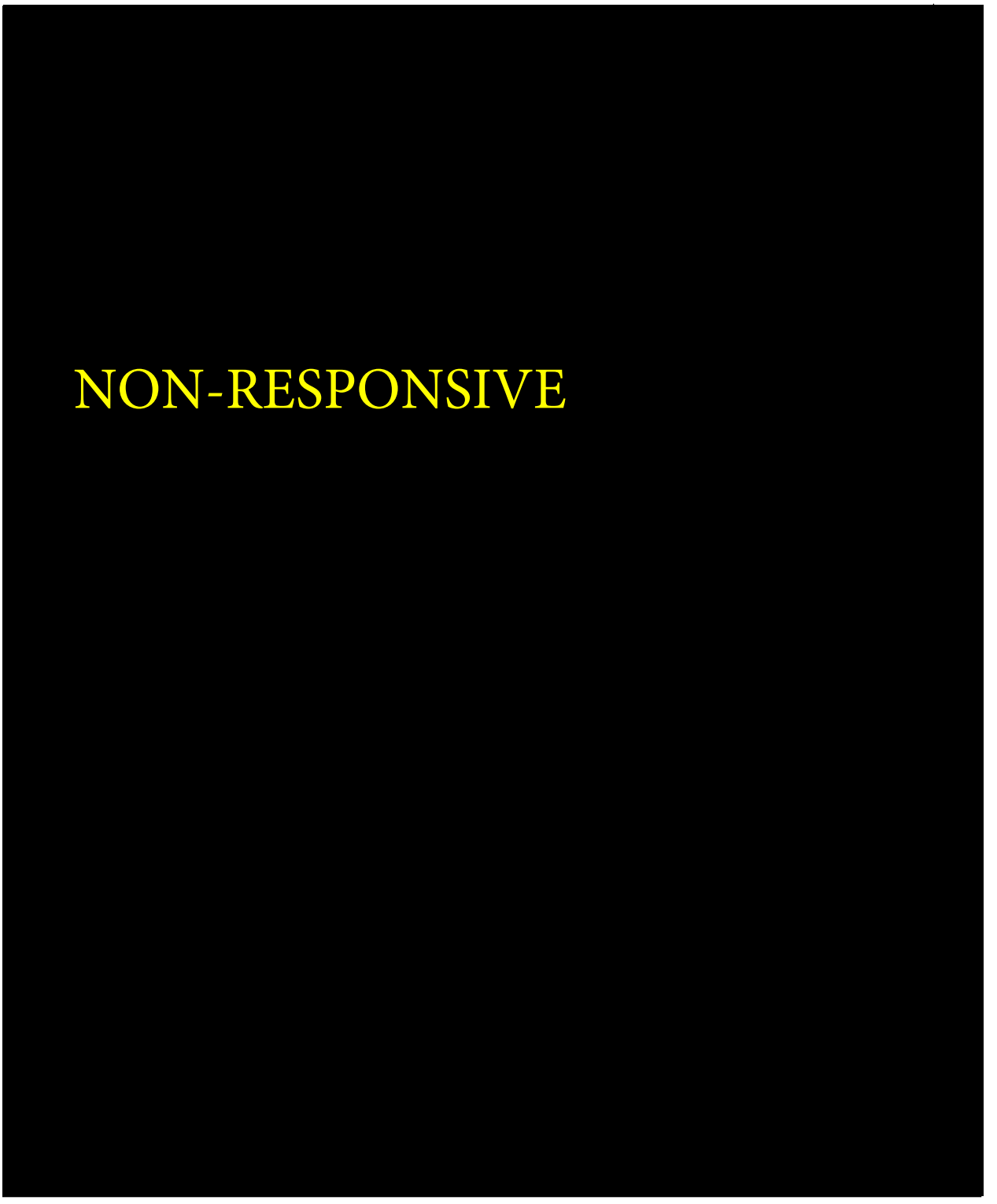
Directions to Methodist Hospital: From the site on Louisiana Ave., south to highway 7 (approximately 0.2 mile). Go east on highway 7 to Brunswick Ave. (approximately 0.6 mile). Turn right on Brunswick and proceed south to Excelsior Blvd. (approximately 0.8 mile). Turn right on Excelsior and proceed west past Dakota Ave. (approximately 0.2 mile). Methodist Hospital is on the right side of excelsior Blvd., immediately after Dakota Ave. (See attached map).

ERT CONTACTS

Health & Safety Mgr. - Kevin Powers (HSM)	617-369-8910
Project Manager - William Gregg (PM)	612-541-1642

OTHER CONTACTS

MPCA - Douglas J. Robohm	612-296-7288
EPA - Daniel J. Bicknell	312-886-7341
RTCC - John C. Craun	317-248-6426
City of St. Louis Park - James N. Grube.	612-924-2551



◉ WELL IN WHICH WATER LEVELS WERE MONITORED WITH A DIGITAL RECORDER DURING PART OF 1978-81

SECTION D
COMMUNITY RELATIONS PLAN

Construction of the Drift-Platteville source control wells will be undertaken pursuant to the provisions of the Consent Decree and Remedial Action Plan for the Reilly Tar & Chemical Corporation St. Louis Park, Minnesota NPL site. All community relations programs related to this work will be coordinated through the following agencies:

United States	Ms. Judy Beck U.S. Environmental Protection Agency Region V (312) 353-1325
State of Minnesota	Ms. Sharon Brustman Minnesota Pollution Control Agency (612) 296-7769
City of St. Louis Park	Ms. Sharon Klumpp City of St. Louis Park (612) 924-2523

APPENDIX A
BORING LOG AND GRAIN SIZE ANALYSIS

STS Consultants Ltd.
Consulting Engineers

Additional Subsurface Exploration and Geotechnical Engineering Evaluation

St. Louis Park Wellhouse
St. Louis Park, Minnesota

ERT, Inc.

Report

STS Consultants Ltd.
Consulting Engineers

2405 Annapolis Lane, Suite 280
Minneapolis, Minnesota 55441
(612) 559-1900

October 29, 1986

Mr. William M. Gregg
ERT, Inc.
5871 Cedar Lake Road
Suite 21
St. Louis Park, MN 55416

STS Project 94026-A

Re: Additional Subsurface Exploration and Geotechnical Engineering Evaluation for the Proposed Lake Street 2 Well St. Louis Park Building to be Located Northwest of the Intersection of Monitor Street and Lake Street in St. Louis Park, Minnesota

Dear Mr. Gregg:

We have completed the subsurface exploration at the above-referenced site. Please find enclosed the results of the exploration and geotechnical engineering recommendations regarding the construction of the wellhouse. If you or representatives of Riley Tar and Chemical Company have any questions with regard to the information contained in this report, please do not hesitate to contact us.

Very truly yours,

STS CONSULTANTS, LTD.

William B. Tepley, EIT
Assistant Project Engineer

Stephan M. Gale, P.E.
Principal Engineer

WBT/dn
Encs.
cc: Mr. Louis Locke
Riley Tar & Chemical Company
P. O. Box 41076
Indianapolis, Indiana 46261

Report

Project

ADDITIONAL SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION FOR THE PROPOSED LAKE STREET 2 WELL ST. LOUIS PARK BUILDING TO BE LOCATED NORTHWEST OF THE INTERSECTION OF MONITOR STREET AND LAKE STREET IN ST. LOUIS PARK, MINNESOTA

Client

Mr. William M. Gregg
ERT, INC.
5871 Cedar Lake Road
Suite 21
St. Louis Park, MN 55416

Project # 94026-A

Date October 29, 1986

STS Consultants Ltd.
Consulting Engineers
2405 Annapolis Lane, Suite 280
Minneapolis, Minnesota 55441
(612) 559-1900

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REPORT SUMMARY

One boring was drilled to a depth of 66-1/2 feet below the existing ground surface for this project. The generalized soil profile consisted of a 5 foot layer of silty sand fill materials underlain by compressible peat soils and organic silty clay to a depth of 20 feet below the existing ground surface. Underlying this organic deposit loose to medium dense sands containing interbedded gravel layers and seams were sampled to a depth of 65 feet below the ground surface. Below 65 feet a thin layer of sandy gravel with interbedded clay seams was sampled overlying inferred limestone bedrock which was encountered at a depth of 66.5 feet. Groundwater was observed in the previous boring performed for the preliminary exploration at a depth of 2.3 feet below the existing ground surface.

In summary, it is our opinion that the proposed wellhouse can be supported on a timber pile foundation system extending through the fill and organic soils to bear in the underlying medium dense sand soil. Details of these recommendations as well as construction considerations are included in the body of this report.

PROJECT OVERVIEW

INTRODUCTION

The subsurface exploration and geotechnical engineering evaluation for the proposed wellhouse to be located northwest of the intersection of Monitor Street and West Lake Street in St. Louis Park, Minnesota has been completed. This work was authorized by Mr. Bill Gregg of ERT on October 20, 1986. The initial scope of work was to provide a single boring drilled to an adequate depth to provide geotechnical recommendations for a pile foundation system for the proposed structure. On October 22, 1986 Mr. Gregg increased the scope of services to include continuous split-spoon sampling between the bottom of the organic soils to the top of the anticipated bedrock surface. The purpose of continuous split-spoon sampling was to more precisely define the soil stratigraphy for design of a proposed well screen. The boring was located adjacent to a previous preliminary boring performed by STS Consultants for our report dated October 14, 1986 (STS Project 94026).

We understand that the proposed wellhouse slab elevation will be located approximately 3 feet above the existing grade. The proposed structure is approximately 9 by 17 feet in plan dimension. The proposed wall construction is to consist of a 6 inch light weight concrete block with a 4 inch brick veneer. The wellhouse is to be constructed over 2 permanently installed pumping wells. The wells are designed as continuous pumping wells which will pump water directly into the sanitary sewer for future treatment. The soil boring locations were laid out in the field by representatives of STS Consultants, Ltd. using the existing roads as reference points. The boring is offset to the southeast of our previous boring in the center of the building by approximately 10 feet. Ground surface elevation of the boring was assumed to be at elevation +100 feet.

The purposes of this report are to (1) describe the soil and groundwater conditions encountered at the boring location, (2) provide geotechnical recommendations for a timber pile foundation, and (3) discuss construction considerations for this project.

EXPLORATION PROCEDURES

SUBSURFACE EXPLORATION PROCEDURES

The subsurface exploration program consisted of drilling one soil boring to a depth of 66.8 feet below the existing ground surface. The soil boring was drilled using a CME-75 truck mounted vehicle. An STS geologist was on-site to log the soil conditions during the drilling operations. The borehole was advanced to a depth of 17.5 feet using hollow stem augers. Beyond 17.5 feet the borings were advanced to the termination using conventional wash boring techniques. During the drilling operation hollow stem augers were advanced to 32.5 feet to seal off the caving of a gravel layer at 31.0 feet. In order to expedite the drilling operations the borehole was advanced to a depth of 16 feet below the existing ground surface prior to obtaining any soil samples. A log of the soil conditions encountered in our previous boring at this location is included in the Appendix. Representative soil samples in the boring was obtained by means of the split-barrel sampling procedure except that continuous sampling was used from 17-1/2 to a depth of 66-1/2 feet. The majority of the sample obtained from the split-spoons were sealed in glass jars and given to Mr. Bill Gregg of ERT for grain size distribution analyses. Field logs of the soil and groundwater conditions encountered and the sampling procedures used during the drilling operations were maintained by the drill crew. The remaining portions of soil samples obtained in the drilling operations were brought to our laboratory for further examination and classification.

LABORATORY TESTING PROCEDURES

The laboratory testing program consisted of classification of the soil samples retained from the drilling operations by an

experienced geologist to determine the major and minor components while also noting the color, degree of saturation and any particular lenses or seams. The soils were classified on the basis of texture and plasticity in general accordance with the "Unified Soil Classification System". The written soil descriptions on the bore logs are in general conformance with the system and the estimated group symbol according to this system of classification is included in parentheses following the soil descriptions on the boring log. A brief explanation of the Unified Soil Classification System is included in the Appendix of this report.

After classification, the geologist grouped the various soil types into the major zones noted on the soil boring logs. The stratification lines indicated on the logs are approximate; in-situ, the transition between soil types may be gradual in both the horizontal and vertical directions.

EXPLORATION RESULTS

SOIL CONDITIONS

The specific soil conditions encountered at each of the boring locations are shown on the respective boring logs in the Appendix. Generalized soil conditions sampled are summarized below.

Fill Materials. Loose to medium dense silty sands were sampled in boring 2 to a depth of approximately 5 feet below ground surface. Standard penetration resistance N-values obtained in the fill soils sampled ranged between 5 to 12 blows per foot. The estimated Unified Soil Classification designation for the fill soils sampled is SM.

Peat. Underlying the fill soils fine fibrous peat followed by an amorphous peat was sampled to a depth of approximately 15 feet below the ground surface. A hand penetrometer test performed on the peat sampled in boring 2 at a depth of 9-1/2 to 11 feet below ground surface indicated an estimated unconfined compressive strength of 0.75 tons per square foot. Standard penetration resistance N-values obtained in the peat soils ranged from 4 to 6 blows per foot. The Unified Soil Classification designation for the peat sampled is Pt.

Organic Silty Clay. An organic silty clay with trace fibers was observed to extend from 15 to 20 feet below the ground surface in boring 2. Sample No. 1 in the recent boring 2B encountered an organic silty clay from 17-1/2 to 19-1/2 feet below the existing ground surface. The estimated Unified Soil Classification for the organic silty clay sampled in borings 2 and 2B is OH.

Sandy Soils. Underlying the organic deposits mentioned above in boring 2B primarily fine to coarse sands were sampled to a

depth of approximately 65 feet below the existing ground surface. Interbedded layers and seams of gravel were observed throughout this unit. Standard penetration resistance N-values were loose to a depth of approximately 30 feet becoming primarily medium dense below 30 feet.

Bedrock. Inferred limestone bedrock was observed at a depth of approximately 66-1/2 feet below the existing ground surface. A thin 1 foot layer of sandy gravel with clay seams was observed immediately over the bedrock surface. A standard penetration N-value of 100 blows per 3 inches was obtained at the suspected bedrock surface.

GROUNDWATER CONDITIONS

Groundwater observations obtained from previous boring 2 showed the groundwater table at a depth of approximately 1-1/2 to 2 feet below ground surface.

Fluctuations in the level of the hydrostatic groundwater table can be expected, depending upon local amounts of precipitation, evaporation, surface runoff and infiltration.

ANALYSIS AND RECOMMENDATIONS

We recommend that the proposed well structure not be supported on the existing fills overlying the buried organic soil deposit. A new surcharge was not recommended previously. Because of the large magnitude and depth of the organic soils sampled a removal and replacement scenario is not likely to be feasible for this site. We also understand that the risk associated with a light weight aggregate replacement would not be acceptable to the client. We therefore recommend that a timber pile foundation be utilized for this project. Our recommendations for a timber pile foundation system are discussed below.

TIMBER PILE FOUNDATION

Based on the data obtained from borings 2 and 2B, we estimate it would be necessary to drive a 12 inch butt diameter treated timber pile to a depth of approximately 40 feet below the existing ground surface of +100 feet (tip elevation 60 feet) to develop a design capacity of approximately 10 tons (ultimate capacity of 35 tons). With the significant depth of compressible peat and overlying fill soils which exist we estimate that a downdrag load of approximately 15 tons per pile may occur. Pile design capacities include a reduction for downdrag and a factor of safety of 2 with respect to ultimate capacity. Required pile penetration should be based on an appropriate dynamic pile driving equation when the pile driving equipment and pile size have been selected. Timber piles should be specified which satisfy ASTM D-25 requirements.

Based on the above design consideration, estimated settlements of timber piles for design loads as previously stated should be less than 3/4 to 1 inch.

We recommend that timber pile support be used for both the structure and the floor slab. We recommend that pile caps and grade beams for a pile supported structure be supported at a frost depth of at least 4 feet below surrounding grade.

FLOOR SLAB DESIGN

We recommend that the floor slab be a structural slab which transmits all slab loads to the foundation. It is our opinion that a slab supported on fill over the peat soils could involve a substantial amount of settlement which would be differential to the well casing.

We recommend that to minimize dampness within the wellhouse, the floor slab should be immediately underlain by a vapor barrier such as a time stable plastic sheeting.

UTILITY SUPPORT RECOMMENDATIONS

Based on the results of the soil borings, we recommend that utilities to the proposed wellhouse be supported on a pile foundation. This would reduce the risk of long-term settlement of the organic soils anticipated at the utility invert elevation.

An alternative to this approach would be to construct the sewer service over the buried organics using ductile iron pipe having mechanical joints. Differential settlement with the wellhouse should be anticipated with this approach. The slope of the service line should be constructed so that positive drainage could be maintained if some settlement were to occur. A civil engineer experienced in utility design should prepare and/or review all utility construction on this site. We recommend that if the alternative approach is used that the sewer line be completely enveloped in a clean sand

bedding having less than 5% silt or clay size particles passing the U.S. No. 200 sieve. The bedding material should be compacted to a minimum of 90% of the maximum Modified Proctor dry density. We recommend that large heavy vibratory compactors not be used for backfilling and compacting over sewer services placed in organic areas. Heavy equipment may cause excessive settlement of the pipe and reduce and possibility of satisfactory performance of this alternative.

CONSTRUCTION CONSIDERATIONS

We recommend that all earthwork and pile driving operations for this project be observed by an experienced STS soil engineer, or technician under his direction.

We recommend that consideration be given to driving the required piles for support of the structure be done prior to the installation of the pumping wells. By using this approach there is less risk in accidentally damaging the proposed wells during the pile driving operation.

GENERAL QUALIFICATIONS

This report has been prepared in order to aid in the evaluation of this property and to assist the architect/engineer in the design of this project. The scope is limited to the specific project and location described herein, and our description of the project represents our understanding of the significant aspects relevant to soil and foundation characteristics. In the event that any changes in the design or location of the structures as outlined in this report are planned, we should be informed so that changes can be reviewed and the conclusions of this report modified or approved in writing by the soil and foundation engineer. AS A CHECK, WE RECOMMEND THAT WE BE AUTHORIZED TO REVIEW PROJECT

PLANS AND SPECIFICATIONS TO CONFIRM THAT OUR REPORT RECOMMENDATIONS HAVE BEEN INTERPRETED IN ACCORDANCE WITH OUR INTENT. WITHOUT THIS REVIEW, WE WILL NOT BE RESPONSIBLE FOR MISINTERPRETATIONS OF OUR DATA, OUR ANALYSIS, AND/OR OUR RECOMMENDATIONS NOR HOW THESE ARE INCORPORATED INTO THE FINAL DESIGN.

It is recommended that all construction operations dealing with earthwork and foundations be reviewed by an experienced soil engineer to provide information on which to base a decision whether the design requirements are fulfilled in actual construction. If you wish, we would welcome the opportunity to provide field construction services for you during construction.

The analysis and recommendations submitted in this report are based on the data obtained from the soil borings performed at the locations indicated on the location diagram and from any other information discussed in this report. This report does not reflect any variations which may occur between these borings. In performance of the subsurface explorations, specific information is obtained at specific locations and at specific times. However, it is a well-known fact that variations in soil and rock conditions exist on most sites between boring locations at specific times. The nature and extent of variations may not become evident until the course of construction. If variations then appear evident, it will be necessary for a re-evaluation of the recommendations of this report after performing on-site observations during the construction period and noting the characteristics of any variations.

Because of the possibility of these unanticipated subsurface conditions occurring, we recommend that a "changed condition" clause be provided in the contract both with the general contractor and in contracts with subcontractors involved in the foundation and earthwork construction. It is felt the

inclusion of this clause will permit contractors to give lower prices because they will not need to provide as much in contingencies as they normally would if equitable adjustment of changed conditions will minimize conflicts and litigation with the attendant delays and costs. Furthermore, by the immediate recognition and adjustment in contract price at the time any changed conditions are encountered, the immense problem of trying to recreate facts when litigation develops later is eliminated. A mediation/arbitration procedure is recommended in the event that the owner, contractor and professionals do not agree on the changed conditions at the moment they are disclosed. If you wish, we would be pleased to furnish additional information pertaining to this procedure.

APPENDIX

1. STANDARD CLAUSE FOR UNANTICIPATED SUBSURFACE CONDITIONS
2. SOIL BORING LOCATION DIAGRAM
3. GENERAL NOTES
4. FIELD AND LABORATORY PROCEDURES
5. BORING LOGS
6. SUBSURFACE EXPLORATION PROCEDURES
7. SAMPLING PROCEDURES
8. LABORATORY PROCEDURES
9. ASTM SPECIFICATION D-1586
10. UNIFIED SOIL CLASSIFICATION SYSTEM

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STANDARD CLAUSE FOR UNANTICIPATED SUBSURFACE CONDITIONS

"The owner has had a subsurface exploration performed by a foundation consultant, the results of which are contained in the consultant's report. The consultant's report presents his conclusions on the subsurface conditions based on his interpretation of the data obtained in the exploration. The contractor acknowledges that he has reviewed the consultant's report and any addenda thereto, and that his bid for earthwork operations is based on the subsurface conditions, as described in that report. It is recognized that a subsurface exploration may not disclose all conditions as they actually exist and further, conditions may change, particularly groundwater conditions, between the time of subsurface exploration and the time of earthwork operations. In recognition of these facts, this clause is entered in the contract to provide a means of equitable additional compensation for the contractor if adverse unanticipated conditions are encountered and to provide a means of rebate to the owner if the conditions are more favorable than anticipated.

At any time during earthwork, paving and foundation construction operations that the contractor encounters conditions that are different than those anticipated by the foundation consultant's report, he shall immediately (within 24 hours) bring this fact to the owner's attention. If the owner's representative on the construction site observes subsurface conditions which are different than those anticipated by the foundation consultant's report, he shall immediately (within 24 hours) bring this fact to the contractor's attention. Once a fact of unanticipated conditions has been brought to the attention of either the owner or the contractor, and the consultant has concurred, immediate negotiations will be undertaken between the owner and the contractor to arrive at a change in contract price for additional work or reduction in work because of the unanticipated conditions. The contractor agrees that the following unit prices would apply for additional or reduced work under the contract. For changed conditions for which unit prices are not provided, the additional work shall be paid for on a time and material basis."

Another example of a changed conditions clause can be found in paper No. 4035 by Robert F. Borg, published in ASCE Construction Division Journal, No. CO2, September 1964, page 37.

NON-RESPONSIVE

STS Consultants Ltd.
Consulting Engineers

NONE

STS DRAWING NO.
94026-A

79581

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS	:	Split Spoon - 1 3/8" I.D., 2" O.D. Unless otherwise noted	OS	:	Osterberg Sampler - 3" Shelby Tube
ST	:	Shelby Tube - 2: O.D., Unless otherwise noted	HS	:	Hollow Stem Auger
PA	:	Power Auger	WS	:	Wash Sample
DB	:	Diamond Bit - NX, BX, AX	FT	:	Fish Tail
AS	:	Auger Sample	RB	:	Rock Bit
JS	:	Jar Sample	BS	:	Bulk Sample
VS	:	Vane Shear	PM	:	Pressuremeter Test, In-Situ
			GS	:	Giddings Sampler

Standard "N" Penetrations: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch O.D. split spoon sampler, except where otherwise noted.

WATER LEVEL MEASUREMENT SYMBOLS:

WL	:	Water Level	WCI	:	Wet Cave In
WS	:	While Sampling	DCI	:	Dry Cave In
WD	:	While Drilling	BCR	:	Before Casing Removal
AB	:	After Boring	ACR	:	After Casing Removal

Water levels indicated on the boring logs are the levels measured in the boring at the times indicated. In pervious soils, the indicated elevations are considered reliable groundwater levels. In impervious soils, the accurate determination of ground water elevations may not be possible, even after several days of observations; additional evidence of ground water elevations must be sought.

GRADATION DESCRIPTION & TERMINOLOGY:

Coarse Grained or Granular Soils have more than 50% of their dry weight retained on a #200 sieve; they are described as: boulders, cobbles, gravel or sand. Fine Grained soils have less than 50% of their dry weight retained on a #200 sieve; they are described as: clays or clayey silts if they are cohesive and silts if they are non-cohesive. In addition to gradation, granular soils are defined on the basis of their relative in-place density and fine grained soils on the basis of their strength or consistency and their plasticity.

Major Component Of Sample	Size Range	Descriptive Term Of Components Also Present in Sample	Percent Of Dry Weight
Boulders	Over 8 in. (200 mm)	Trace	1 - 9
Cobbles	8 inches to 3 inches (200 mm to 75 mm)	Little	10 - 19
Gravel	3 inches to #4 sieve (75 mm to 4.76 mm)	Some	20 - 34
Sand	#4 to #200 sieve (4.76 mm to 0.074 mm)	And	35 - 50
Silt	Passing #200 sieve (0.074 mm to 0.005 mm)		
Clay	Smaller than 0.005 mm		

CONSISTENCY OF COHESIVE SOILS:

Unconfined Compressive Strength, Qu, tsf	Consistency
< 0.25	Very Soft
0.25 - 0.49	Soft
0.50 - 0.99	Medium (Firm)
1.00 - 1.99	Stiff
2.00 - 3.99	Very Stiff
4.00 - 8.00	Hard
> 8.00	Very Hard

RELATIVE DENSITY OF GRANULAR SOILS:

N - Blows per ft.	Relative Density
0 - 3	Very Loose
4 - 9	Loose
10 - 29	Medium Dense
30 - 49	Dense
50 - 80	Very Dense
80+	Extremely Dense

STS Field and Laboratory Procedures

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In the process of obtaining and testing samples and preparing this report, standard procedures are followed regarding field logs, laboratory data sheets and samples.

Specifically, field logs are prepared during performance of the drilling and sampling operations which are intended to portray essentially field occurrences, sampling locations and other information.

Samples obtained in the field are frequently subjected to additional testing and reclassification in the laboratory by more experienced soil engineers, and differences between the field logs and the final logs exist.

The engineer preparing the report reviews the field and laboratory logs, classifications and test data, and in his judgement in interpreting this data, may make further changes.

Samples taken in the field, some of which are later subjected to laboratory tests, are retained in our laboratory for sixty days and are then destroyed unless special disposition is requested by our client. Samples retained over a long period of time, even in sealed jars, are subject to moisture loss which changes the apparent strength of cohesive soil, generally increasing the strength from what was originally encountered in the field. Since they are then no longer representative of the moisture conditions initially encountered, an inspection of these samples should recognize this factor.

It is common practice in the soil and foundation engineering profession that field logs and laboratory data sheets not be included in engineering reports, because they do not represent the engineer's final opinions as to appropriate descriptions for conditions encountered in the exploration and testing work. On the other hand, we are aware that perhaps certain contractors and subcontractors submitting bids or proposals on work might have an interest in studying these documents before submitting a bid or proposal. For this reason, the field logs will be retained in our office for inspection by all contractors submitting a bid or proposal. We would welcome the opportunity to explain any changes that have and typically are made in the preparation of our final reports, to the contractor or subcontractors, before the firm submits its bid or proposal, and to describe how the information was obtained to the extent the contractor or subcontractor wishes. Results of laboratory tests are generally shown on the boring logs or are described in the text of the report, as appropriate.

The descriptive terms and symbols used on the logs are described on the attached sheet, entitled. General Notes.

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OWNER: Riley Tar & Chemical	LOG OF BORING NUMBER: B-2
PROJECT NAME: Proposed Well House	ARCHITECT-ENGINEER: ERT

SITE LOCATION: St. Louis Park, Minnesota

DEPTH in feet / ELEVATION	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³	UNCONFINED COMPRESSIVE STRENGTH TONS FT.² (1 2 3 4 5) / PLASTIC LIMIT % / WATER CONTENT % / LIQUID LIMIT % (10 20 30 40 50) / STANDARD PENETRATION BLOWS FT (10 20 30 40 50)
SURFACE ELEVATION							
	1	SS			Silty fine to medium sand, trace coarse sand and roots - dark brown to black - moist - loose - (SM) - (fill)		⊗5
	2	SS					⊗12
5.0	3	SS			Fine to coarse sand, little gravel, little silt - brown - wet to saturated - medium dense - (SM) - (fill)		
	3A	SS					⊗4
	4	SS			Fine fibrous peat - black - (Pt)		⊗5
10.0	5	SS			Amorphous peat - black - (Pt)		6⊗
15.0	6	SS					
	6A	SS			Organic silty clay, trace fibers - white - firm - (OH)		⊗4
20.0	7	SS					
	7A	SS			Fine to coarse sand, trace gravel and silt - gray - saturated - medium dense - (SP) Note: Cresote like odor in sample 7 and 8.		⊗10
25.0	8	SS					⊗10
					End of boring at 26.0 ft. Hollow stem auger to full depth.		O* - calibrated penetrometer

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN SITU, THE TRANSITION MAY BE GRADUAL.

WL 2.3 ft. WS	WS OR WD	BORING STARTED 9/29/86	STS OFFICE Minnesota		
WL BCR	ACR	BORING COMPLETED 9/29/86	DRAWN BY KC	SHEET NO. 1 OF 1	
WL 1.5 ft. AB		RIG CME-45 FOREMAN GD	APP'D BY WBT	STS JOB NO. 94026	

BL 1-983

STS Consultants Ltd.

OWNER: Riley Tar & Chemical	LOG OF BORING NUMBER: B-33
PROJECT NAME: Proposed Well House	ARCHITECT—ENGINEER: ERT
SITE LOCATION: St. Louis Park, Minnesota	

DEPTH / ELEVATION	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE / RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT³	UNCONFINED COMPRESSIVE STRENGTH TONS/FT² 1 2 3 4 5 · PLASTIC LIMIT · WATER CONTENT · LIQUID LIMIT 10 20 30 40 50 · STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50
				SURFACE ELEVATION +100 feet		
				Hollow stem augered to 17.5 feet - see log of boring #2 for soil conditions above 17.5 feet		
	1	SS		Organic silty clay, little sand - dark brown - firm - (OH)		3
	2	SS		Clayey silt - gray - soft - (ML - CL)		10
	2A	SS				5/6"
	3	SS		Silty sand - gray - saturated - medium dense - (SM)		3
	4	SS		Fine to coarse sand, little gravel, trace silt - gray - saturated - loose - (SW - SP)		10
	5	SS		Note: 31.0 feet driller notes hole caving due to gravel		6
	6	SS				11
	7	SS		Fine to medium sand, trace coarse sand, trace gravel, trace silt - brown - saturated - medium dense - (SP)		16
	8	SS				30
	9	SS		Silty sand, trace gravel - brown - saturated - medium dense - (SM)		27
	10	SS				14/6"
	10A	SS		Sandy gravel, trace silt - gray - saturated - medium dense - (GP)		8/6"
	11	SS				13
	12	SS		Fine to coarse sand, trace gravel, trace silt - gray - saturated - medium dense - (SP) - (SW)		8
	13	SS				10
	14	SS				27
	15	SS				29
	16	SS				15
	17	SS				17
	18	SS				23
	19	SS				22
	20	SS				18
	21	SS				14
	22	SS				3/6"
	23	SS		Fine to medium sand, little silt, trace gravel - brown - medium dense - (SM)		17
	24	SS		Sandy gravel, trace silt - gray - saturated - medium dense - (GP)		24
	25	SS				21
	26	SS		Fine to coarse sand, trace to little gravel, trace silt - gray - saturated - medium dense - (SW) - (SP)		19
	27	SS				10
	28	SS		Sandy gravel, trace silt - gray - saturated - medium dense - limestone gravel - (GP) - (clay seams)		20
	29	SS				50/3"
	29A	SS		Platteville limestone		100/3"

End of boring at 66.8 ft.

Hollow stem augered to 17.5 ft. Drilled with 2 15/16" rockbit and bentonite drilling fluid 17.5 ft. to 32.5 ft. Caving gravel 31 feet. Set hollow stem to 32.5 ft. Drilled with 2 15/16" rockbit and bentonite drilling fluid from 32.5-66.0 ft. Grouted hole with neat cement grout.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN SITU. THE TRANSITION MAY BE GRADUAL.

WL	WS OR WD	BORING STARTED	10/24/86	STS OFFICE	Minnesota		
WL	BCR ACR	BORING COMPLETED	10/24/86	DRAWN BY	AN	SHEET NO.	1 OF 1
WL		RIG CME-75	FOREMAN GD	APP'D BY	DCJ	STS JOB NO.	94026

BLS 0184

SUBSURFACE EXPLORATION PROCEDURES

Hand-Auger Drilling (HA)

In this procedure, a sampling device is driven into the soil by repeated blows of a sledge hammer. When the sampler is driven to the desired sample depth, the soil sample is retrieved. The hole is then advanced by manually turning the hand auger until the next sampling depth increment is reached. The hand auger drilling between sampling intervals also helps to clean and enlarge the bore hole in preparation for obtaining the next sample.

Power Auger Drilling (PA)

In this type of drilling procedure, continuous flight augers are used to advance the bore holes. They are turned and hydraulically advanced by a truck or track-mounted unit as site accessiblility dictates. In auger drilling, casing and drilling mud are not required to maintain open bore holes.

Hollow Stem Auger Drilling (HS)

In this drilling procedure, continuous flight augers having an open stem are used to advance the bore holes. The open stem allows the sampling tool to be used without removing the augers from the bore hole. Hollow stem augers thus provide support to the sides of the bore hole during the sampling operations.

Rotary Drilling (RB)

In employing rotary drilling methods, various cutting bits are used to advance the bore holes. In this process, surface casing and/or drilling fluids are used to maintain open bore holes.

Diamond Core Drilling (DB)

Diamond core drilling is used to sample cemented formations. In this procedure, a double tube (triple tube) core barrel with a diamond bit cuts an annular space around a cylindrical prism of the material sampled. The sample is retrieved by a catcher just above the bit. Samples recovered by this procedure are placed in sturdy containers in sequential order.

SAMPLING PROCEDURES

Auger Sampling (AS)

In this procedure, soil samples are collected from cuttings off of the auger flights as they are removed from the ground. Such samples provide a general indication of subsurface conditions; however, they do not provide undisturbed samples, nor do they provide samples from discrete depths.

Split-Barrel Sampling (SS) — (ASTM Specification D-1586-84)

In the split-barrel sampling procedure, a 2 inch O.D., split barrel sampler is driven into the soil a distance of 18 inches by means of a 140 pound hammer falling 30 inches. The value of the Standard Penetration Resistance is obtained by counting the number of blows of the hammer over the final 12 inches of driving. This value provides a qualitative indication of the in-place relative density of cohesionless soils. The indication is qualitative only, however, since many factors can significantly affect the Standard Penetration Resistance Value, and direct correlation of results obtained by drill crews using different rigs, drilling procedures, and hammer-rod-spoon assemblies should not be made.

Shelby Tube Sampling Prodecure (ST) — (ASTM Specification D-1587-83)

In the shelby tube sampling procedure, a thin-walled steel seamless tube with a sharp cutting edge is pushed hydraulically into the soil and a relatively undisturbed sample is obtained. This procedure is generally employed in cohesive soils.

Giddings Sampler (GS)

This type of sampling device consists of 5-ft. sections of thin-wall tubing which are capable of retrieving continuous columns of soil in 5-ft. maximum increments. Because of a continuous slot in the sampling tubes, the sampler allows field determination of stratification boundaries and containerization of soil samples from any sampling depth within the 5-ft. interval.

LABORATORY PROCEDURES

Water Content (Wc)

The water content of a soil is the ratio of the weight of water in a given soil mass to the weight of the dry soil. Water content is generally expressed as a percentage.

Hand Penetrometer (Qp)

In the hand penetrometer test, the unconfined compressive strength of a soil is determined to a maximum value of 4.5 tons per square foot (tsf), by measuring the resistance of the soil sample to penetration by a small, spring-calibrated cylinder. The hand penetrometer test has been carefully correlated with unconfined compressive strength tests, and thereby provides a useful and a relatively simple testing procedure in which soil strength can be quickly and easily estimated.

Unconfined Compression Tests (Qu)

In the unconfined compression strength test, a soil is loaded axially until failure or until 20% strain has been reached, whichever occurs first. This test is performed on undisturbed samples obtained from the shelby tube sampling procedure.

Classification of Samples

In conjunction with the sample testing program, all soil samples are examined in our laboratory and classified on the basis of their texture and plasticity in accordance with the Unified Soil Classification System (USCS). The soil descriptions on the boring logs are in conformance with this system and the estimated group symbols according to this system are included in parentheses following the soil descriptions on the boring logs. Included on a separate sheet is a brief explanation of this system of soil classification.

AMERICAN SOCIETY FOR TESTING AND MATERIALS

Standard Method for

PENETRATION TEST AND SPLIT-BARREL SAMPLING OF SOILS[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This method has been approved for use by agencies of the Department of Defense and for listing in the DOD Index of Specifications and Standards.

1. Scope

1.1 This method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. For a specific precautionary statement, see 5.4.1

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Applicable Documents

2.1 ASTM Standards:

D2487 Test Method for Classification of Soils for Engineering Purposes[2]

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D4220 Practices for Preserving and Transporting Soil Samples[2]

3. Descriptions of Terms Specific to This Standard

3.1 anvil—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passses into the drill rods.

3.2 cathead—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.3 drill rods—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.4 drive-weight assembly—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.5 hammer—that portion of the drive-weight assembly consisting of the 140 ± 2 lb (63.5 ± 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.6 hammer drop system—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.7 hammer fall guide—that part of the drive-weight assembly used to guide the fall of the hammer.

3.8 N-value—the blowcount representation of the penetration resistance of the soil. The N-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.10 number of rope turns—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.11 sampling rods—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.12 SPT—abbreviation for Standard Penetration Test, a term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations which relate SPT blowcount, or N-value, and the engineering behavior of earthworks and foundations are available.

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[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Sept. 11, 1984. Published November 1984. Originally published as D1586—58T. Last previous edition D1586—67 (1974).

[2] Annual Book of ASTM Standards, Vol 04.08

5. Apparatus

5.1 Drilling Equipment—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions.

5.1.1 Drag, Chopping, and Fishtail Bits, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2 Roller-Cone Bits, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 Hollow-Stem Continuous Flight Augers, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 Solid, Continuous Flight, Bucket and Hand Augers, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 Sampling Rods—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅜ in. (28.5 mm).

NOTE 1—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the N-values to depths of at least 100 ft (30 m).

5.3 Split-Barrel Sampler—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted ont he penetration record if used.

NOTE 2—Both theory and available test data suggest that N-values may increase between 10 to 30% when liners are used.

5.4 Drive-Weight Assembly:

5.4.1 Hammer and Anvil—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 Hammer Drop System—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 Accessory Equipment—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 mm) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments

so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-kg) hammer and count the number of blows applied in each 6-in. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the applicaion of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance", or the "N-value". If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lb (63.5-kg) hammer shall be accomplished using either of the following two methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) unimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may be used during the performance of the penetration test, as shown in Fig. 1.

NOTE 4—The operator should generally use either 1¾ of 2¼ rope turns, depending upon whether or not the rope comes off the top (1¾ turns) or the bottom (2¼ turns) of the cathead. It is generally known and accepted that 2¾ or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the percent recovery or the length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job,

8.1.2 Names of crew,

8.1.3 Type and make of drilling machine,

8.1.4 Weather conditions,

8.1.5 Date and time of start and finish of boring,

8.1.6 Boring number and location (station and coordinates, if available and applicable),

8.1.7 Surface elevation, if available,

8.1.8 Method of advancing and cleaning the boring,

8.1.9 Method of keeping boring open,

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.1.11 Location of strata changes,

8.1.12 Size of casing, depth of cased portion of boring,

8.1.13 Equipment and method of driving sampler,

8.1.14 Type of sampler and length and inside diameter of barrel (note use of liners),

8.1.15 Size, type, and section length of the sampling rods, and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number,

8.2.2 Description of soil,

8.2.3 Strata changes within sample,

8.2.4 Sampler penetration and recovery lengths, and

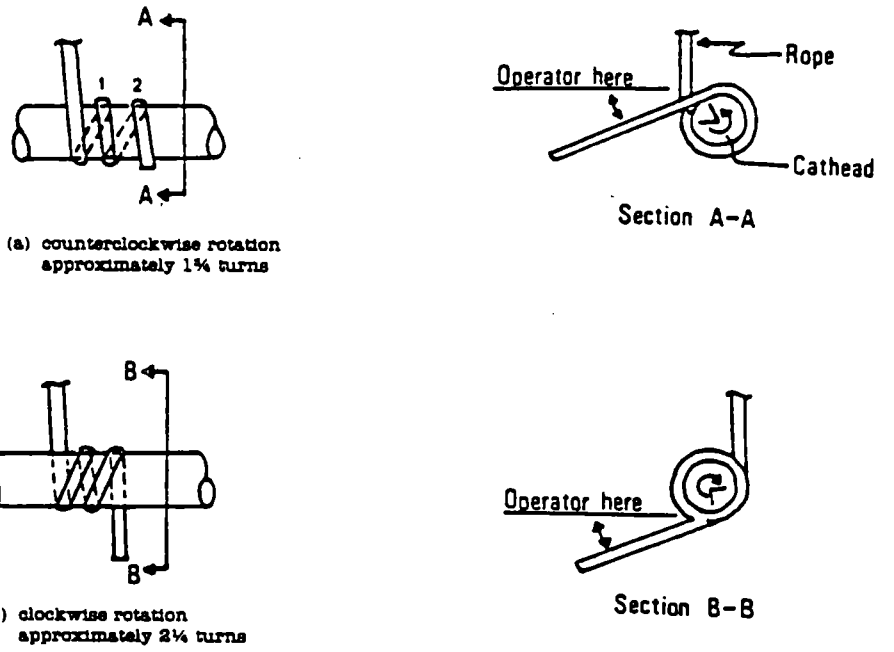
8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

9. Precision and Bias

9.1 Variations in N-values of 100% or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, N-values in the same soil can be reproduced with a coefficient of variation of about 10%.

9.2 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in N-values obtained between operator-drill rig systems.

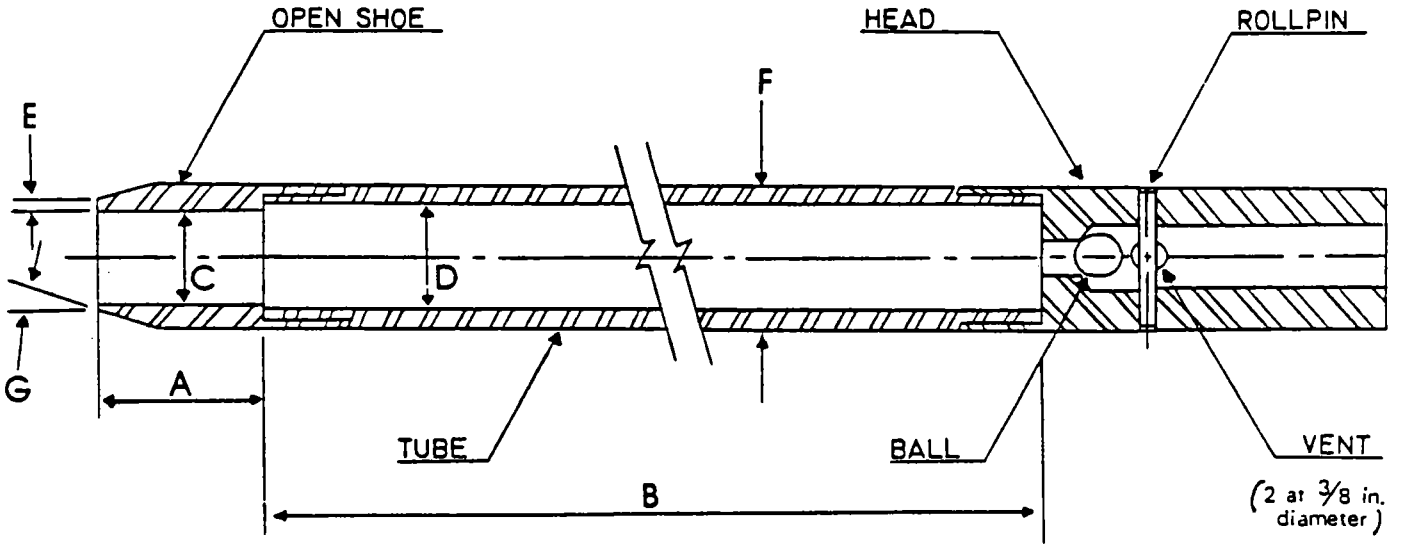
9.3 The variability in N-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjustng N on the basis of comparative energies. A method for energy measurement and N-value adjustment is currently under development.



(a) counterclockwise rotation approximately 1¾ turns

(b) clockwise rotation approximately 2¼ turns

FIG. 1 Definitions of the Number of Rope Turns and the Angle for (a) Counterclockwise Rotation and (b) Clockwise Rotation of the Cathead



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 − 0.00 in. (38.1 ± 1.3 − 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 − 0.00 in. (50.8 ± 1.3 − 0.0 mm)
G = 16.0° to 23.0°

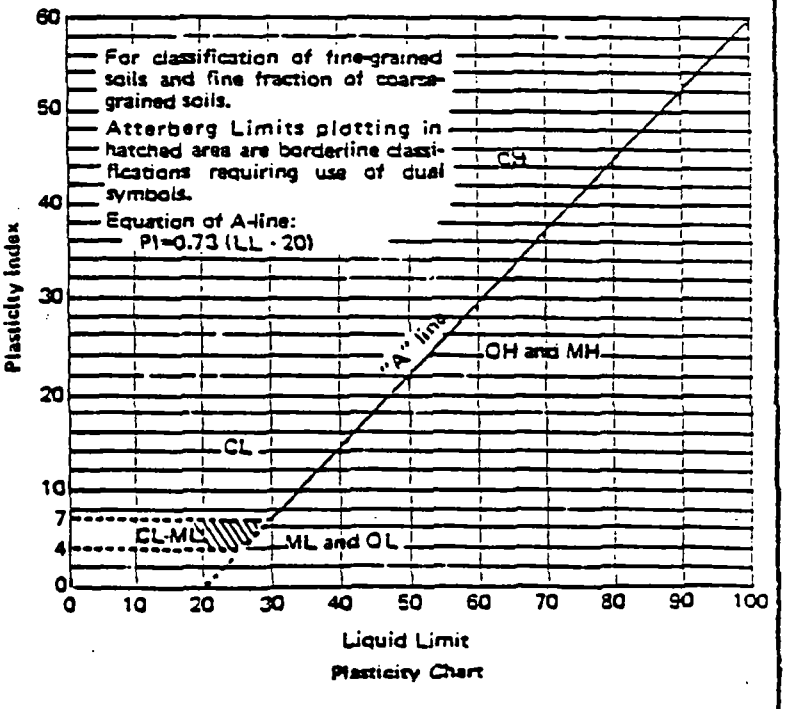
The 1⅜ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

UNIFIED SOIL CLASSIFICATION SYSTEM

Major divisions			Group symbols	Typical names	Laboratory classification criteria
Coarse-grained soils (More than half of material is *larger* than No. 200 sieve size)	Gravels (More than half of coarse fraction larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW
		Gravels with fines (Appreciable amount of fines)	GM d / u	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 — Above "A" line with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above "A" line with P.I. greater than 7
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW
		Sands with fines (Appreciable amount of fines)	SM d / u	Silty sands, sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 — Limits plotting in hatched zone with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols.
			SC	Clayey sands, sand-clay mixtures	Atterberg limits above "A" line with P.I. greater than 7
Fine-grained soils (More than half of material is *smaller* than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL	Organic silts and organic silty clays of low plasticity	
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
			CH	Inorganic clays of high plasticity, fat clays	
			OH	Organic clays of medium to high plasticity, organic silts	
Highly organic soils			Pt	Peat and other highly organic soils	

Determine percentages of sand and gravel from grain-size curve.
Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:
Less than 5 per cent . . . . . GW, GP, SW, SP
More than 12 per cent . . . . . GM, GC, SM, SC
5 to 12 per cent . . . . . *Borderline* cases requiring dual symbols



Plasticity Chart

ERT®
A RESOURCE ENGINEERING COMPANY
5871 CEDAR LAKE RD., SUITE 21, ST. LOUIS PARK, MINNESOTA 55416, (612) 541-1642

environmental and engineering excellence

October 29, 1986

Mr. Al Smith
Johnson Screens

Dear Al,

The enclosed samples were collected from a soil boring in St. Louis Park. In general, fill, peat, and organic clay were encountered from the surface to a depth of about 24 feet. Mostly sands and some gravel were encountered from 24 feet to the bedrock (Platteville Fm.) at about 66 feet. We wish to install a 6-inch diameter well (with pipe-size screen) in the drift at this location, and would like to maximize the specific capacity of the well. Therefore, we are sending you the samples from the soil boring so that you may recommend an appropriate custom-made screen for this location. We will be purchasing the well screen for this well, and for one other drift well for which samples will be sent to you later, in the Spring of 1987.

Attached to this letter is a copy of a section of the work plan that the MPCA and U.S. EPA are now reviewing that provides a background and additional information concerning this well installation program. While no significant changes to this plan are likely to occur, it is possible that, after a period of time, the pumping rate in this well will be increased above 25 gpm. Therefore, we stress that a screen that delivers the largest amount of water possible is desired. Also, recommendation on a gravel-packed screen versus a naturally developed well, and on any other relevant installation procedures would be most appreciated.

By way of clarification, Reilly Tar & Chemical Corporation is responsible for the well installation. ERT, Inc. is Reilly's lead consultant for this work, and STS Consultants Ltd. were contracted to perform the pilot boring and collect the samples that you now have. If I can be of any further help to you, for your purpose of designing the well screen for this installation, please call me at 541-1642. Thank you very much for your assistance in this matter.

Sincerely,

William M. Gregg

William M. Gregg
Hydrogeologist

WMG/ct

Enclosure

ERT Sample Log Sheet

Reilly Tar & Chemical Corporation
Drift Aquifer Source Control Well
Performed by STS (job# 94026)

D222-292
Pilot Boring

10-24-86

Sample No.	Depth, Ft.	Sample No.	Depth, Ft.
S-1	No Recovery	S-16	46-47.5
S-2*	20-22	S-17	47.5-49
S-3*	22.5-24.5	S-18	49-50.5
S-4	25-27	S-19	50.5-52
S-5	27.5-29	S-20	52-52.5
S-6	29.5-31	S-21	54-55.5
S-7	No Recovery	S-22	55.5-57
S-8	32.5-34	S-23	57-58.5
S-9	34-36	S-24	58.5-60
S-10	40-42	S-25	60-61.5
S-11	38-39.5	S-26	61.5-63
S-12	39.5-41	S-27	63-64.5
S-13	41.5-43	S-28	64.5-66
S-14	43-44.5	S-29	66-67.5
S-15	44.5-46		

* Samples of "cuttings" only

ERT

DRILLER STS CONSULTANTS, LTD.

ENGINEER ERT
ST. LOUIS PARK, MINNESOTA 55416

ANALYSIS BY ALBERT J. SMITH
DATE 13 NOVEMBER, 1986

JOB NAME

LOCATION

JOHNSON I.D. NUMBER 86321E1
SAMPLE SENT IN BY ERT

SAND ANALYSIS REPORT

Johnson Division
P.O. Box 64118 St. Paul, Minn. 55164
Tel. 612-636-3900
800-328-9110
Telex 297451

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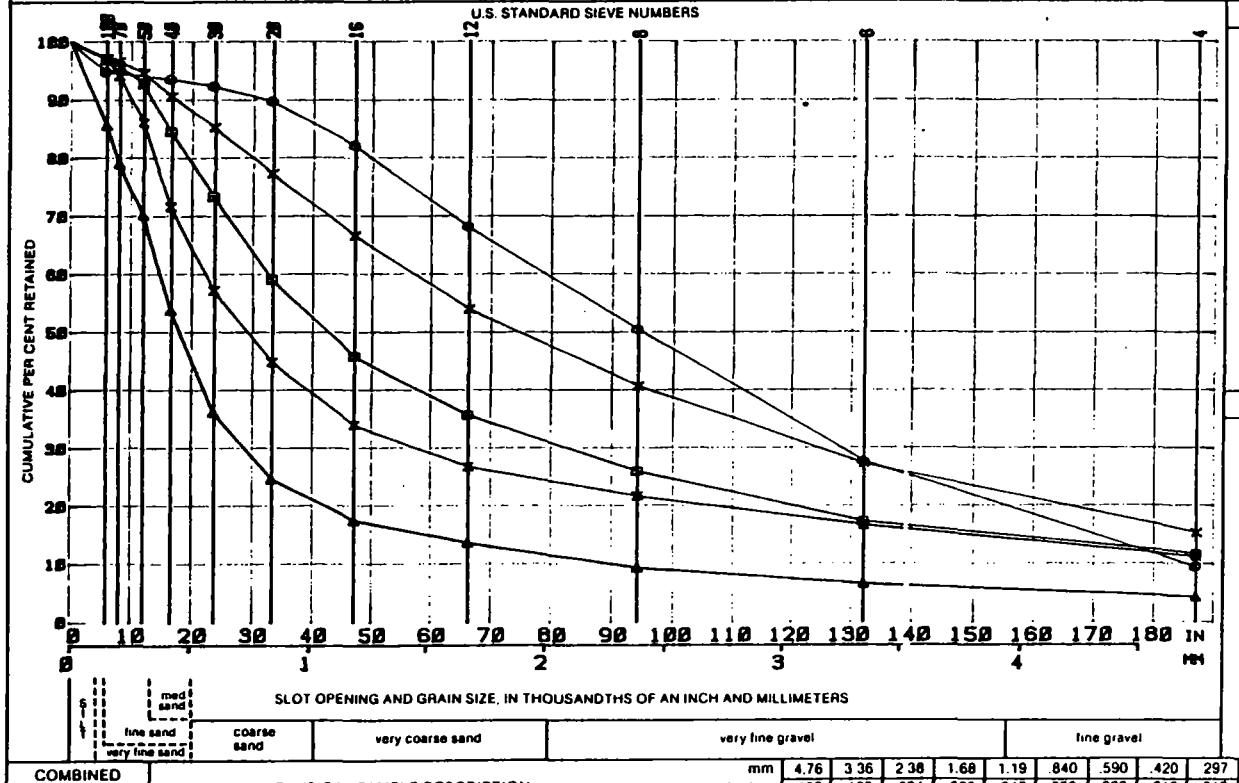

TEST HOLE DATA

DIAMETER

DEPTH 67.5 FEET

DRILLING METHOD

DRILLING FLUID

GEOPHYSICAL LOGS

STATIC WATER LEVEL

COMMENTS

Centering guides would be required to center the 6" pipe size screen within the 10" diam. borehole.

WELL DATA

CASING DIAMETER

DESIRED YIELD

WELL APPLICATION

DESIGN RECOMMENDATIONS

We recommend use of #30 American Materials Gravel Pack.

SCREEN RECOMMENDATIONS

DIAMETER 6 P.S.

SLOT	LENGTH	SETTING
40	50	20-70

COMBINED SAMPLE DEPTHS	PHYSICAL SAMPLE DESCRIPTION		mm	4.76	3.36	2.38	1.68	1.19	.840	.590	.420	.297	.210	.149	.074	.053	TOTAL WT.
			Inches	187	.123	.094	.066	.047	.033	.023	.016	012	008	006	003	.002	
			U.S. Sieve #	4	6	8	12	16	20	30	40	50	70	100	200	270	
28 / 24.5 FT.	O SAMPLES #S-2 & #S-3	CUMULATIVE % RETAINED		9.5	27.8	58.6	68.4	82.3	89.9	92.4	93.7			94.9			158.8
25 / 34 FT.	□ SAMPLES #S-4, S-5, S-6 & S-8			11.7	17.3	26.8	35.7	45.9	59.2	73.5	84.7	92.9	95.9	98.9			196.8
34 / 42 FT.	Δ SAMPLES #S-9 & S-10			4.4	6.6	9.3	13.7	17.8	24.7	38.3	53.8	78.3	79.1	85.7			182.8
38 / 41 FT.	⧗ SAMPLES #S-11 & S-12			11.2	16.7	21.7	28.8	34.1	44.9	57.2	71.7	88.2	94.2	97.1			278.8
41.5-47.5 FT.	X SAMPLES #S-13, S-14, S-15 & S-16			15.3	27.3	48.7	54.8	68.7	77.3	85.3	98.7	94.7	98.7	97.3			388.8

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS

SAND ANALYSIS REPORT

DRILLER

ENGINEER

ANALYSIS BY

DATE 19 NOVEMBER, 1986

JOB NAME

LOCATION

JOHNSON I D. NUMBER 86321E2

SAMPLE SENT IN BY ERT

Johnson Division
P.O. Box 64118 St. Paul, Minn. 55164
Tel. 612-636-3900
800-328-9110
Telex 297451

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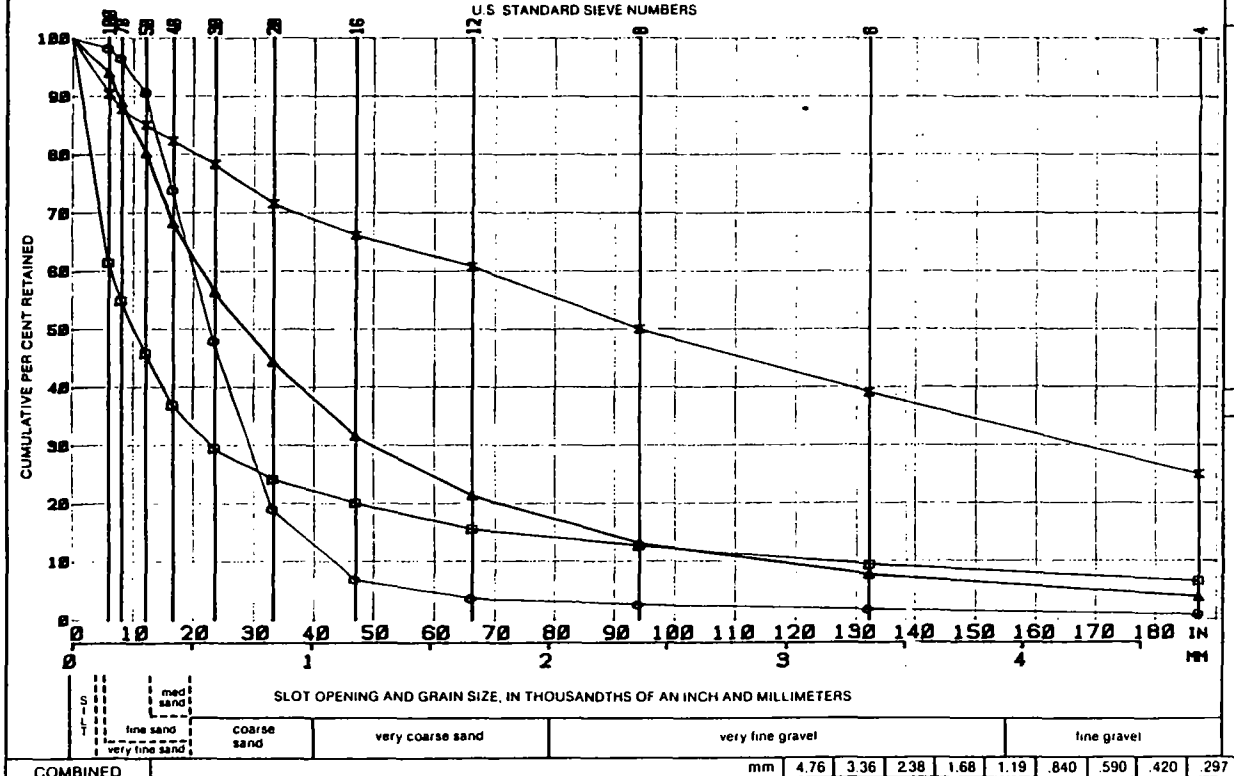


TEST HOLE DATA

DIAMETER

DEPTH

DRILLING METHOD

DRILLING FLUID

GEOPHYSICAL LOGS

STATIC WATER LEVEL

COMMENTS

WELL DATA

CASING DIAMETER

DESIRED YIELD

WELL APPLICATION

DESIGN RECOMMENDATIONS

SCREEN RECOMMENDATIONS

DIAMETER

COMBINED SAMPLE DEPTHS	PHYSICAL SAMPLE DESCRIPTION		mm	4.76	3.36	2.38	1.68	1.19	.840	.590	.420	.297	.210	.149	.074	.053	TOTAL WT.
			Inches	.187	.123	.094	.066	.047	.033	.023	.016	.012	.008	.006	.003	.002	
			U.S. Sieve#	4	6	8	12	16	20	30	40	50	70	100	200	270	
47 - 57 FT.	O SAMPLES #S-18,S-17,S-19,S-20,S-21,S-22	CUMULATIVE % RETAINED		0.9	1.7	2.6	3.8	6.9	19.1	48.0	74.0	90.0	96.5	98.3			346.0
57 - 68 FT.	□ SAMPLES #S-23 & S-24			6.6	9.4	12.7	15.6	28.1	24.2	29.5	38.9	45.9	54.9	61.5			244.0
68 - 88 FT.	Δ SAMPLES #S-25, S-26, S-27 & S-28			3.0	7.7	19.2	21.4	31.6	44.4	56.4	68.4	80.3	88.9	94.0			294.0
88 - 97.5 FT.	X SAMPLES #S-29			25.0	39.2	50.0	60.0	68.2	71.6	78.4	82.4	85.1	87.0	90.5			148.0

SLOT	LENGTH	SETTING

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS

APPENDIX B

HEAD LOSS CALCULATIONS

APPENDIX B

HEAD LOSS CALCULATIONS

The pump sizes for the Drift-Platteville source control wells are both based on the need to pump 25 gpm of water against 110 feet of head, with some margin for higher pumping rates to make up for down time. The total discharge heads are comprised of the following head losses:

Item	Feet of Head
Combined discharge pipe & fittings	1
Net head lift	26
Pipe & fitting losses	2
Equipment losses	81

	110

The pipe and fitting losses were calculated using standard friction factors. The equipment losses are comprised of 21 feet of head across the backflow preventer, 25 feet across the flow meter, and 35 feet across the flow controller. 3.5'

The net head lifts were estimated from recent water level data and predicted drawdowns. Water levels measured by the MPCA in Drift and Platteville observation wells in January 1985 indicate a groundwater elevation of about 885 feet in the vicinity of the proposed source control wells in each aquifer (see Figures 8 and 9 in the Drift-Platteville Aquifer Northern Area Remedial Investigation Plan submitted by the City of St. Louis Park in January 1987). The aquifer

analysis and aquifer parameters presented in the Aquifer Test Plan section of the Site Management Plan yield predicted drawdowns on the order of a few feet when pumping the source control wells at 25 gpm in the Drift and Platteville aquifers. However, to be conservative and allow for possible declines in static water levels, a drawdown of 25 feet was assumed in estimating net head lifts. Finally, drawing no. 861637-300 shows that the design elevation of the discharge line below the pumphouse is about 886 feet (176 feet by St. Louis Park datum). With these data, the net head lift for each source control well can be calculated as: 886 - 885 + 25 = 26 feet.

APPENDIX C

ERT STANDARD OPERATING PROCEDURES 7730

AQUIFER TEST AND DATA EVALUATION

NOTE: Discrepancies between this SOP and the Site Management Plan will be resolved by following procedures described in the Site Management Plan.

STANDARD OPERATING PROCEDURE

Number: 7730 Date of Issue: 2nd Qtr. 1986

Title: AQUIFER TEST AND DATA EVALUATION

Organizational Acceptance	Authorization	Date
Originator	[signature]	[illegible]
Department Manager	[signature]	5-24-86
Divisional Manager	D E Andrews	5/28/86
~~Group~~ Quality Assurance ~~Officer~~ Manager	Scott M. Mattson	5-27-86
Other		

Revisions	Changes	Authorization	Date

Title: AQUIFER TEST AND DATA EVALUATION

1.0 PURPOSE/APPLICABILITY

This SOP is concerned with the procedures necessary for aquifer-test design, aquifer-test performance and general techniques of data evaluation. The scope of this SOP is limited to general procedures necessary to properly understand and organize an aquifer test. A detailed test plan should be prepared before beginning an aquifer test, following the general guidelines given in this SOP. More detailed studies concerning aquifer tests and analyses can be found in any of the various references listed at the end of this SOP.

Aquifer tests are generally conducted to evaluate the hydraulic properties of an aquifer system as they relate to remedial action design criteria and/or water supply studies.

2.0 RESPONSIBILITIES

The project manager or his delegate (a qualified hydrologist, hydrogeologist, geologist, etc.) will have the responsibility of designing an appropriate aquifer-test program specific to the project needs. Additionally, he or she will be responsible for coordinating any second or third parties and ensuring that all procedures are performed in accordance with SOP and the aquifer-test plan. Any deviation from the SOPs or the aquifer-test plan will be fully documented in a daily log book.

2.1 ERT Personnel

The ERT project manager or his delegate will be responsible for:

- Aquifer-test design - This will include review of pertinent hydrogeologic literature (reports, boring and well logs, etc.) and, based on that information, the preparation of a site-specific aquifer-test plan that specifies: (1) the placement of monitoring and recovery wells; (2) site-specific discharge rates and point of discharge; and (3) time intervals at which water level data will be collected.
- Aquifer-test performance - This includes: (1) implementation of the aquifer test in accordance with job-specific protocols given in the aquifer-test plan; and (2) recording aquifer-test data.
- Reduction and evaluation of aquifer-test data - This will include: (1) evaluation of antecedent water-level trends; (2) evaluation of the pumping phase water-level data; and (3) evaluation of the recovery phase water-level data.

2.2 Drillers

It is the responsibility of the driller to provide the necessary equipment for monitoring and recovery well installation as specified in SOP 7220 and as modified by the project manager or his delegate. If the driller is to supply submersible pumps, generators, flow meters, discharge lines or any other equipment necessary to the job the project manager shall explain in detail to the subcontracted driller the job-specific equipment needs. During setup and/or installation of the equipment the project manager shall oversee the performance and adherence to the test plan. Additionally, during the entire aquifer test, if the driller is involved in activities such as monitoring the performance of the pumps, fuel supplies, etc., the project coordinator shall ensure that the driller adheres to the test plan.

2.3 Second or Third Parties

During the aquifer test other involved parties shall be monitored for performance and adherence to the test plan. Any deviation shall be corrected and fully recorded by the project coordinator in a daily log book.

3.0 SUPPORTING MATERIALS

The following list identifies the types of equipment which may be used during an aquifer-test program. Exact equipment needs will be project-specific and will be detailed in the aquifer-test plan.

3.1 ERT

- Electric water-level indicator
- Steel surveyors tape and plopper
- Pressure transducer and data logging system
- 100-foot surveyors tape
- Field portable printer or computer (compatible with data logging system)
- Aquifer-test record sheets/clip board
- Daily log book

- Log-log and semi-log graph paper
- Watch
- Calculator
- Decontamination equipment (required for personal protection during aquifer tests in potentially contaminated environments or if sampling for chemical analysis will be included):

  Alconox detergent
  Chemical-free paper towels
  Deionized water w/squeeze bottle
  Methanol w/squeeze bottle
  Trash bags
  Tap water (5 gallons)
  Buckets

- Ground-water sampling kit from lab (if applicable)
- Personnel health and safety equipment (as specified by the HSO)
- Submersible pump
- Aeration column (for stripping volatiles out of discharged ground water)

3.2 Driller

- Tankers for collecting discharged ground water
- Submersible pump
- Generator and fuel
- Flow meters and control valves
- Discharge line

3.3 Supporting SOPs

- 2005 - Numerical Analysis and Peer Review
- 7220 - Monitoring Well Construction and Installation

4.0 GENERAL AQUIFER TEST DESIGN AND OPERATIONAL PROTOCOLS

Aquifer tests are broken down into four separate phases, all of which must be performed for proper evaluation of the hydraulic properties of the aquifer. Any deviation from these four phases must be fully documented and justified. These four phases are:

- Aquifer-test design
- Antecedent water-level monitoring
- Pumping
- Recovery
- Aquifer-Test Design

Prior to an aquifer test an initial review of site hydrological and geological conditions must be performed and a detailed aquifer-test plan must be prepared. Information concerning aquifer thickness, aquifer type, transmissivity, hydraulic conductivity, storativity, etc., can be obtained or estimated from the following types of sources:

- Boring logs
- Well records
- USGS water resource reports
- State water resource reports
- Textbook tables and charts

The hydrogeologic information gathered from these sources is necessary to:

- estimate the cone of influence at a specific discharge rate;
- properly and strategically locate monitoring wells and the recovery well; and
- determine the proper time intervals at which time-drawdown data should be collected.

The following subsections provide guidelines for preparation of aquifer-test plans.

4.1.1 Cone of Influence

The cone of influence which will result from pumping of the aquifer must be estimated for proper placement of monitoring wells. Analysis of the cone of influence is performed using: (1) analytical techniques described in Section 5.0; (2) known and/or estimated hydraulic characteristics of the aquifer system; and (3) the project-specific discharge rate.

4.1.2 Recovery Wells

Recovery well design is mainly dependent upon the heterogeneity of the aquifer system to be tested. Standard design considerations which should be evaluated under all situations are as follows:

- The inside diameter of the recovery well and well screen should be sufficient to allow for installation of the submersible pump.
- The well screen should be of sufficient slot-size opening to prevent entrainment of finer grained sediment while keeping the screen intake velocity and head loss at a minimum.
- The recovery well should be properly developed prior to the aquifer test.

The screened interval of the recovery well is dependent upon the heterogeneity of the aquifer system. Under fairly homogeneous, isotropic conditions the recovery well should be screened over 70 to 80 percent of the aquifer's entire thickness. More heterogeneous, anisotropic conditions may require a specific screened interval dependent upon the formational unit to be tested. Under complex heterogeneous anisotropic conditions the placement of the recovery well screen must be evaluated by a qualified hydrogeologist.

4.1.3 Monitoring Wells

Monitoring well design is largely dependent upon the heterogeneity of the aquifer system to be tested. Standard design considerations which should be evaluated under all situations are as follows:

- The inside diameter of the monitoring well should be sufficient to allow for installation of water-level monitoring equipment and ground-water sampling equipment.

- A minimum of five monitoring wells should be used for the collection of water level and drawdown data.

- Monitoring wells should be properly developed prior to the aquifer test to ensure proper hydraulic continuity with the aquifer system.

Under fairly homogeneous, isotropic conditions the following rules for proper monitoring well placement should be observed:

- Monitoring well screens should extend to at least a depth equal to the midpoint of the recovery well.

- The closest monitoring well should be located at a radial distance, from the recovery well, equal to the saturated thickness of the aquifer.

- At least one monitoring well should be located outside of the predetermined cone of influence.

- For a confined aquifer, shallow monitoring wells should be placed in the overlying source bed (if any).

Figure 1 shows a typical setup of monitoring wells and the recovery well along with major assumptions for homogeneous, isotropic conditions. More heterogeneous, anisotropic aquifer systems may require discreet screen placement within specific geologic units. This placement shall be determined by a qualified hydrogeologist.

4.2 Antecedent Water-Level Monitoring

Antecedent water-level trends must be established prior to startup of the recovery well pump. Antecedent water-level trends include:

- Diurnal fluctuations due to daily ground-water withdrawals in the area

- Seasonal water-level fluctuations

- Changes in water levels due to changes in the atmospheric barometric pressures
- Changes in water levels due to tidal cycles
- Changes in water levels due to daily traffic patterns

Dedicated, continuously recording, pressure transducers and data logging systems should be employed to establish antecedent water-level trends. Water levels should be monitored at no greater than hourly intervals in at least three monitoring wells to establish any spatial trends within the aquifer system. Data should be collected until a water level trend can be established but for no less than a 24-hour period. The observed antecedent trend also can be used to locate possible ground-water supply wells which may cause interference during the aquifer test. All efforts should be made to reduce the use of any well which may cause interference during the aquifer test.

During analyses of the aquifer-test data, antecedent water-level trends are extrapolated out through the pumping and recovery phases of the aquifer test. Water level and drawdown data are then corrected for any established antecedent trend.

4.3 Pumping Phase

During the pumping phase of the aquifer test the recovery well pump is switched on and run at the specified discharge rate. All technicians who will be collecting data shall synchronize their watches and begin collecting water level data when the recovery well pump is switched on. Water level data shall be collected at the time intervals shown in Table 1 or as specified by the project manager. All appropriate aquifer-test data shall be recorded on the aquifer-test data record sheet (Figure 2). Each person recording data shall sign and date, in ink, his or her record sheet.

The duration of the aquifer test shall be determined by the project manager. For a valid aquifer test the recovery well should be pumped until changes in drawdown become negligible, the hydraulic gradient becomes constant and/or changes in the discharge rate from aquifer to the recovery well approach zero. These criteria determine the type of solution, steady state or non-steady state, that will be used in analyzing the aquifer-test data. The forementioned conditions indicate steady-state conditions. Steady-state conditions will allow for the most accurate evaluation of the aquifer's hydraulic characteristics.

The duration of the aquifer test can be estimated during the design phase while judgments in the field as to the state of ground-water flow can be made once data has been collected for a sufficient period of time. Aquifer tests should however be run for no less than 12 hours. A practical maximum duration of 72 hours will provide sufficient data to characterize hydraulic properties of the aquifer. Large aquifer systems which may be used for major municipal supplies should be tested for 7 to 14 days to evaluate long-term pumping affects.

The discharge rate should be measured and adjusted (if necessary) at least hourly throughout the entire aquifer test. Ground water withdrawn from the recovery well must be discharged at a suitable distance outside of the radial cone of influence. This will prevent artificial recharge back into the aquifer system. If artificial recharge into the aquifer system being tested occurs, erroneous results will be calcylated during analyses of the aquifer-test data.

4.4 Recovery Phase

During the recovery phase of the aquifer test the recovery well pump is switched off and water level rebounds are measured in all monitoring wells and the recovery well at the time intervals listed in Table 1. Monitoring of the water level rebound should continue until the aquifer has recovered to within 90 percent of its initial water level. It is usually sufficient to monitor for a 24-hour period. Long-term pumping, however, should be followed by long-term monitoring of water level recovery and post-aquifer-test water level trends.

5.0 AQUIFER-TEST ANALYSES

Once the aquifer test has been completed, field data must be reduced, assimilated and evaluated. Data analyses include three main procedures:

1) Water level data must be corrected for antecedent trends observed during phase two of the aquifer test.

2) Time-drawdown data collected during the pumping phase of the aquifer test must be plotted on log-log paper. These log-log plots are then matched to known aquifer type responses shown in Figure 3.

3) Aquifer-test data must be analyzed using appropriate type solutions as listed in Tables 2 and 3.

Aquifer-test data which has been corrected for any antecedent trends is plotted on log-log paper. These plots are then matched to typical responses of known aquifer types as shown in Figure 3. Once the type of aquifer response has been evaluated, the project manager must select the proper solutional technique to evaluate the aquifer-test data. Table 2 lists the various methods of data analyses and calculated hydraulic properties which can be used if the following assumptions are met:

- The aquifer has infinite areal extent.
- The aquifer is homogeneous, isotropic and of uniform thickness.
- Prior to pumping, the piezometric surface and the phreatic surface are nearly horizontal.
- The discharge rate is constant.
- The aquifer is fully penetrated by the recovery well.
- Storage within the recovery well can be neglected.
- Water removed from the aquifer is discharged instantaneously with a decline in hydraulic head.

More detailed analyses may be necessary under complex hydrogeologic conditions. Table 3 lists techniques of aquifer-test analyses with replaced assumptions indicative of more complex hydrogeologic conditions. In any case, the assumptions on which analyses are based should be stated in the final report.

All aquifer-test analyses must be performed by a qualified hydrogeologist. The list of references at the end of this SOP provide detailed methods of analyses for all hydrogeologic conditions.

6.0 REVIEW

All data reduction, calculations and assumptions shall be verified, by a qualified person other than the originator, in accordance with SOP 2005 (Numerical Analysis and Peer Review). In addition to protocols listed in SOP 2005, the verification process shall include a review of:

- Assumptions made for antecedent water-level trends

- Major assumptions as listed in Section 5.0 for aquifer type and solutional technique
- Overall method of analyses and reporting of results

All reviews shall be signed by the reviewer prior to reporting of analyses to the client.

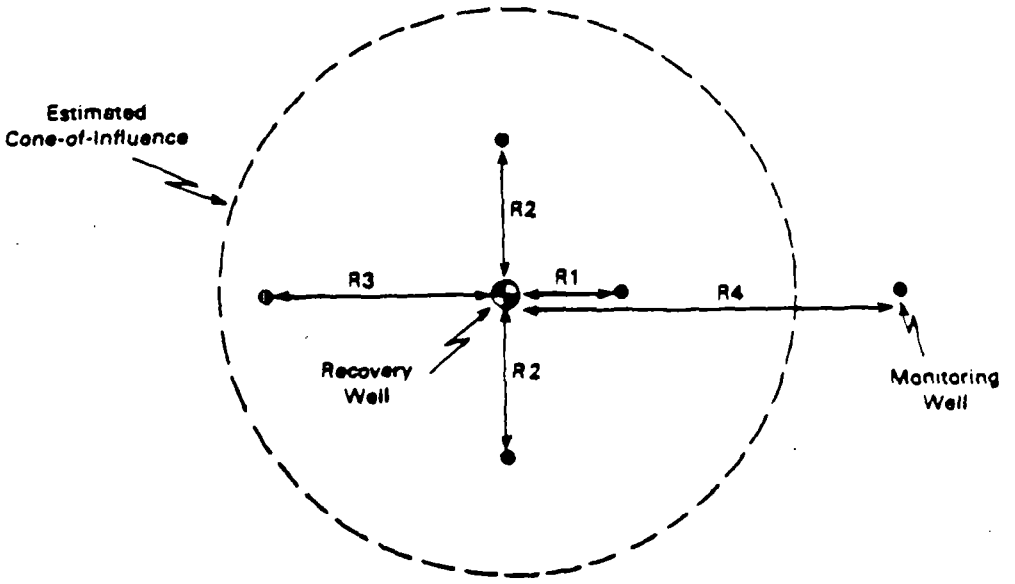
REFERENCES

Ground Water Manual, A Water Resources Technical Publication, U.S. Department of the Interior, 1977.

Ground Water; R. Allan Freeze and John A. Cherry, 1979.

Practical Aspects of Ground Water Modeling, Flow, Mass and Heat Transport, and Subsidence; Analytical and Computer Models. William C. Walton, 1984.

Analysis and Evaluation of Pumping Test Data; Bulletin 11. Kruseman G.P. and DeRidder N.A.



Where:

R = Radial Distance from the Recovery Well
and R1 < R2 < R3 < R4

Aquifer Assumptions:

- The aquifer has infinite areal extent.
- The aquifer is homogeneous, isotropic and of uniform thickness.
- Prior to pumping the piezometric surface and phreatic surface are nearly horizontal.
- The discharge rate is constant.
- The aquifer is fully penetrated by the recovery well.
- The storage in the recovery well can be neglected.
- Water removed from the aquifer is discharged instantaneously with a decline in hydraulic head.

Figure 1 Generalized Aquifer Test Set Up

TABLE 1

PREDETERMINED MEASUREMENT INTERVALS

Time Since Test-Started	Measurement Interval
0 - 1 hr	1 - 5 mins
1 - 3 hrs	15 mins
3 - 5 hrs	30 mins
5 - 24 hrs	60 mins
24 - 48 hrs	2 - 4 hrs
48 - 72 hrs	4 - 8 hrs

Well # _____
Pg 1 of ____

AQUIFER TEST DATA RECORD SHEET

Date _____ Technician _____
Project _____
Depth of Well _____ Length of Screen _____
Time Test Started _____ hrs. Length of Casing (AGS) _____
Radial Distance from Pump Well _____
Static Water Level (TOC) _____

Watch Time	Time Since Test Started	Water Level from T.O.C.	Adjusted Water Level	Drawdown (ft)	Pump Rate

Figure 2 Aquifer Test Data Record Sheet

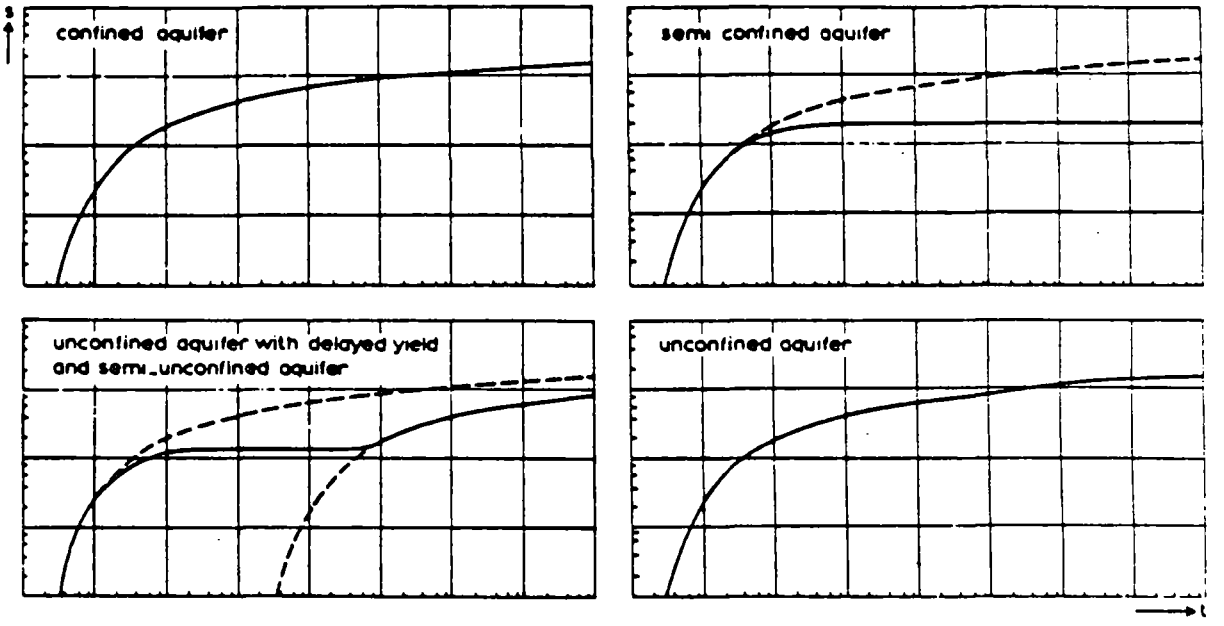


Figure 3 Typical Time-Drawdown Curves for Different Aquifer Types

TABLE 2

ANALYTICAL PROCEDURES FOR EVALUATING AQUIFER-TEST DATA

Aquifer Type	Type of Solution	Method of Analysis		Calculated Parameters*
		Name	Type	
confined	steady state	Thiem	calculation	T,K
	unsteady state	Theis	curve fitting	T,S,K
		Chow	nomogram	
		Jacob	straight line	T,S,K
		Theis recovery	straight line	T,K
semi confined	steady state	De Glee	curve fitting	T,C,K,L
		Hantush Jacob	straight line	T,C,K,L
		Ernst mod. Thiem meth.	calculation	T,K
	unsteady state	Walton	curve fitting	T,S,K,C,L
		Hantush I	inflection point	T,S,K,C,L
		Hantush II	inflection point	
		Hantush III	curve fitting	T,S,K,C,L
unconfined with delayed yield and semi-unconfined	unsteady state	Boulton	curve fitting	T,S_A,S_Y,B,1/α,K
unconfined	steady state	Thiem-Dupuit	calculation	T,K
unsteady state	as for confined aquifers			T,S,K

Note: T = Transmissivity; K = Horizontal Hydraulic Conductivity; S = Storativity; C = Hydraulic Resistance; L = Leakage Factor; S_A = Storativity; S_Y = Specific Yield; 1/α = Delay Index; B = Drainage Factor

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TABLE 3

ANALYTICAL PROCEDURES FOR EVALUATING AQUIFER-TEST DATA

Replaced Assumption(s)	Aquifer Type	Type of Solution	Method of Analysis: Name	Method of Analysis: Type	Conditions	Calculated Parameters*
Aquifer crossed by one or more fully penetrating recharge or barrier boundaries	confined or unconfined	steady state	Dietz	calculation	recharge boundaries only	T,K
		unsteady state	Stallman	curve fitting	recharge and/or barrier boundaries	T,K,S
			Hantush image	straight-line	one recharge boundary	
Aquifer homogeneous, anisotropic and of uniform thickness	confined or unconfined	unsteady state	Hantush	calculation		T_X,T_Y,S,K
			Hantush-Thomas	calculation	for recovery data also	T_X,T_Y,S,K
	semi confined	unsteady state	Hantush	calculation		T_X,T_Y,S,C,L,K
Aquifer homogeneous and isotropic; but thickness varies exponentially	confined	unsteady state	Hantush	curve fitting	4D/dx < 0.20	T,S,K
Prior to pumping the phreatic surface slopes in the direction of flow	unconfined	steady state	Culmination point	calculation		T,K
		unsteady state	Hantush	curve fitting	i < 0.20	T,S,K
Discharge rate variable	confined or unconfined	unsteady state	Cooper-Jacob	straight line	step-type pumping	T,K,S
			Aron-Scott	straight line	continuously decreasing discharge	T,K,S
			Sternberg	straight line	continuously decreasing discharge	T,K,S
			Sternberg recovery	straight line	continuously decreasing discharge	T,K

Note: T = Transmissivity; K = Horizontal Hydraulic Conductivity; S = Storativity; C = Hydraulic Resistance; L = Leakage Factor; T_X,T_Y = Transmissivity in the X and Y direction.

APPENDIX D

CONTRACT SPECIFICATIONS

CONTRACT SPECIFICATIONS

FOR

DRIFT AND PLATTEVILLE AQUIFERS

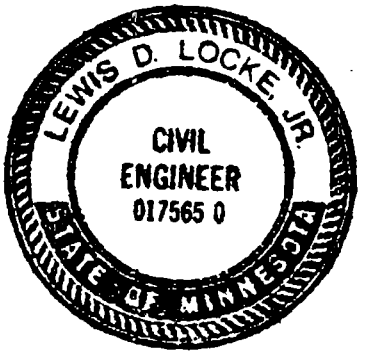
SOURCE CONTROL WELLS

REILLY TAR & CHEMICAL CORP.

1510 MARKET SQUARE CENTER

151 NORTH DELAWARE STREET

INDIANAPOLIS, IN 46204



I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

Lewis D. Locke, Jr.

Date OCT 31 1986 Reg. No. 017565 0

PUMPING FACILITY ENGINEERING SPECIFICATIONS

CONTENTS

SECTION 100

SUMMARY OF WORK

101 SCOPE OF WORK

The work consists of the complete finish of the Drift and Platteville aquifers source control wells Pump House at _____Lake St., St. Louis Park, MN. The work is to be completed as per this specification and Reilly Tar & Chemical Corp. drawings 861737-001, 300, 601 and 604.

102 OWNER RESPONSIBILITIES

The Owner will have a Representative available for field Consultation.

The Owner will furnish site elevations prior to letting the work for bids.

The Owner will furnish all required construction and permanent permits.

103 CONTRACTOR RESPONSIBILITIES

The Contractor will supply the Owner with a schedule of construction before the work begins and with a revised and updated schedule weekly as the work progresses.

The Contractor will arrange for a temporary water supply and temporary electrical service connection during the construction period.

The Contractor shall provide project management to ensure completion of the work on schedule.

The Contractor will be responsible for base lines and bench marks for subcontractor use.

The Contractor must notify the Owner 3 days in advance of any utility tie-in or any work that will interrupt normal activity around the job site.

Coordination between the Contractor and the Subcontractors must be maintained in order to meet the schedule.

All applicable Codes and Safety Regulations will be followed by every Contractor and his workers.

The Contractor shall provide five copies of all equipment warranties, operating instructions, installation instructions, maintenance instructions and parts list for each piece of equipment installed shall be provided to the owner on completion of the work.

The Contractor shall provide temporary baricades and fencing.

The Contractor shall ensure that at the end of each working day, positive drainage shall be provided.

The Contractor shall ensure that the topsoil is removed to its entire depth, in the areas of new construction and stockpile topsoil which will be required for finish grading.

The Contractor shall see that areas that are to have topsoil removed shall first be cleared of excessive vegetation, rubbish and debris.

The Contractor shall see that stockpiled topsoil is replaced in lawn areas prior to sodding and or seeding to a minimum depth of 6 inches. Remove all stones larger than 2 inches.

The Contractor will be responsible for site restoration to near original condition. Sod shall be placed where necessary to return site to original conditions or to prevent erosion otherwise graded areas shall be seeded.

The Contractor shall be responsible for layout of his Work, including lines and elevations. Each Subcontractor shall field verify all dimension relating to his work, as shown on the Drawings, and report any errors or discrepancies to the General Contractor before commencing work.

The Contractor is responsible for the protection of his Work from adverse weather. He shall provide, at all times, all means and methods for weather protection as necessary for the satisfactory execution and performance of his work.

104 GUARANTEES

A written one year guarantee is required to cover all installed material, equipment and labor not otherwise covered by manufacturers warranties. Exceptions to this are the roof (2 yrs) and caulking (5 yrs).

All guarantees will begin at the Owners recognized date of substantial completion.

105 TEMPORARY FACILITIES

The Contractor will furnish a project office at the site with a telephone for business use to all personnel. Toilet facilities will be provided by the Contractor.

Storage facilities are to be provided by the Contractor. Set-up location must be approved by the Owner. If the set-up location interferes with work later in the job, relocation may be required.

The Electrical Subcontractor will furnish all temporary electrical for lights and outlets at the beginning of the job. This temporary work is to be included in the Contract Bid. This work must meet the appropriate codes and regulations.

The Electrical Subcontractor is also responsible for removal of this equipment when no longer needed.

Fire extinguishers will be provided by the Contractor at required locations on the job site. Each Subcontractor is responsible for providing his own extinguishers during any cutting or welding. Certain Owner designated locations will require Owner approval before welding or cutting can be done.

Project Sign: If required, the Contractor will provide and maintain a Project Sign as approved by the City and the Owner. No other signs are allowed except as required for safety, security, or traffic control; or without the permission of the Contractor.

106 MEETINGS

Prior to Contract award, the leading Bidder will be required to attend a pre-award meeting. At this time the bid and all applicable Contract Document information will be reviewed. A preliminary schedule will be provided for Contractor input. The Contractor should also be ready to provide information on Subcontractors, Suppliers, material and equipment delivery times, personnel etc.

At any time during the job, the Owner may call a progress meeting in the St. Louis Park area. These meetings may require attendence by the Contractor, Subcontractors and Material Suppliers.

107 SHOP DRAWINGS

Shop drawings and product data must be received by the Owner with sufficient time for approval. Contractor or Supplier delay in forwarding drawings and data for approval will not be viewed as an acceptable reason for schedule extension.

Seven (7) copies of all approved drawings and data will be supplied to the Owner for further distribution.

108 CLEAN-UP

The Contractor and each Subcontractor will be responsible for site clean-up during the job. A trash container will be supplied by the Contractor.

109 PROJECT CLOSEOUT

The Mechanical and Electrical Subcontractors must submit five (5) sets of operating and maintenance manuals to the Owner before final payment will be made. These manuals will contain the following:

- Contractor and Supplier List
- Guarantees
- Wiring and control diagrams
- Operating instructions
- Maintenance instructions
- Parts lists
- Any other information relating to supplied equipment and materials

The Contractor and all Subcontractors must submit a Contractor and Supplier List and a written guaranty.

The Contractor will be responsible for keeping a set of as-built drawings on site for updating changes. It is the responsibility of each Subcontractor to note all changes related to his work on this set.

SECTION 200

MECHANICAL WORK

201 GENERAL

This Section describes work, equipment and materials to be furnished by the Mechanical Subcontractor.

All mechanical systems are to be finished to a ready-to-operate condition. The Mechanical Contractor is responsible for completing all mechanical systems except for power wiring tie-ins.

The accompanying drawings have been drawn to scale and have some listed dimensions. Care has been taken to maintain accuracy, but it remains the Contractors responsibility to verify the scaled and listed dimensions.

The Mechanical Subcontractors Bid shall include a list describing the major types of equipment and materials to be used. After acceptance of the bid, changes to this list will not be allowed.

The Mechanical Contractor will assume all responsibility for conforming to rules and regulations of the applicable government agencies and utilties.

The plumbing installation will comply with all requirements of the Minnesota Department of Health and the Uniform Plumbing code.

The mechanical installation will comply with the Uniform Mechanical Code.

All installed work will comply with rules and recommendations of the National Fire Protection Association.

Shop drawings and operation and maintenance manuals must be supplied as described in the SUMMARY OF WORK.

202 SYSTEM TESTING

Every piping system will be flushed clean prior to pressure testing.

Testing procedures for all piping systems are as follows:

Air Test: The air test shall be made by attaching an air compressor testing apparatus to any suitable opening, and, after closing all other inlets and outlets to the system, forcing air into the system until there is a uniform gauge pressure of 5 pounds per square inch (5 psi/34.47 kPa) or sufficient to balance a column of mercury 10 inches (254 mm) in height. This pressure shall be held without introduction of additional air for a period of at least 15 minutes.

203 MECHANICAL EQUIPMENT SPECIFICATIONS

(Equipment is listed as per well)

Discharge Gate Valves 1 1/2" NPT (Powell Fig. 500)

Pressure Gauges (2) 0-100 psi (Ashcroft 1279 (*) 54 1/2"
TA Lower 1/2 NPT 0-100 psi)

Flow Controllers 1 1/2" NPT (Kates Flow Control IB11T-CDG)

Sample Line Valves and Pressure Gauge Shutoff Valves
1/2" NPT, ball type (Powell Fig. 4210B 1/2")

Flow Meters 1 1/2"NPT (Hersey Turbine Meter MVR100-C-I-150-P-G-C
with 1005 pulse to DC converters, manufacturers
calibration records are required for these devises)

Backflow Check Valves 2", spring closing (TRW
Mission Duo Check II K15 HMF 2")

Reduced Pressure Backflow Preventers 1 1/2" NPT (FEBCO 825Y
with gate valves)

204 GENERAL PIPING MATERIALS

The Mechanical Contractor is to furnish all piping, valves and accessories to complete the work as described by the Contract Documents. Substitutions may be made for specified items with approval from the owner.

The list of acceptable manufacturers is as follows:

- Gate and check valves: Nibco/Scott, Crane, Powell, Lunken, TRW Mission Heimer, Walworth, Jenkins or Stockman

- Ball valves: Wolverine Brass Works, Nibco/Scott, Hammond, Powell, Jamesbury, Metraflex or Dyna-Quip

All flange connections are to have 1/16" full face "Cranite" gaskets coated with a thread lubricant when installed.

205 GENERAL PIPING INSTALLATION

All piping must be installed and routed in a neat and orderly manner with sufficient clearances for maintenance unless otherwise indicated on the drawings.

206 GAUGES

Acceptable guage manufacturers are Ashcroft, Marsh, Trerice, Duro, Danton, Cambridge, American Air Filter or Dryer.

Typical guages shall be similar to the following:

- Ashcroft 1279

207 DISCHARGE WATER PIPING

Piping will be part low carbon steel galvanized Sch 40 ASTM A120/A53 with screwed and flanged fittings and part insulated polyethylene coated carbon steel Sch 40 ASTM A120/A53 as indicated on the drawings.

208 DRAIN PIPING

Piping will be part no hub cast iron ASA Group 022, ASTM A74, ANSI 112.5.13, ASTM C564 gasket sleeves, CISPI 310 couplings and part insulated polyethylene coated carbon steel Sch 40 ASTM A120/A53 as indicated on the drawings.

209 GENERAL EQUIPMENT INFORMATION

The Mechanical Subcontractor is responsible for complete purchasing and installation of all equipment other than as noted in the Drawings and Specifications. This work includes supports and all connections except power wiring to the unit.

All equipment is to be completely installed to a ready to operate state, including any lubrication, alignment and adjustments.

SECTION 300

ELECTRICAL WORK

301 GENERAL

This section describes work, equipment and materials to be furnished by the Electrical Subcontractor.

The Electrical Subcontractor will assume all responsibility for conforming to all rules and regulations of the applicable government agencies and utilities.

The Electrical Subcontractor is responsible for verification of dimensions that affect his work. Any minor deviations caused by interferences shall be considered a part of the job and the owner will not be held responsible for any reimbursement.

All electrical equipment must be U. L. approved and meet all other applicable code requirements.

All permits and inspections required for completion of electrical work are to be arranged and paid for by the Owner.

All electrical materials and equipment shown on the Contract Drawing and listed in the Specifications must be provided by the Electrical Subcontractor unless otherwise noted.

Shop Drawings and Operations and Maintenance Manuals must be supplied as described in the SUMMARY OF WORK.

302 TEMPORARY WORK

The Electrical Subcontractor must supply temporary power supply pole and outlets to allow for convenient construction use.

303 ELECTRICAL EQUIPMENT SPECIFICATIONS:

Pumps, 2 units each being 2 Hp, 3ph, 200V, 60He, 8 amps (furnished by Well Contractor)

Nema Size 0 starters 2 units each being (Square D class 8536, type SBW, Nema type 4 with Dual Push Button and pilot light control unit KXRG117, fused 120V control transformer extra contact)
Hour meters non reset type (Redington 7526-002)
Two 25 amp circuit breaker disconnects in load center (Square D Q0325) 3 pole, common trip with indicator

Heaters 2 units each being 5KW, 17,065 Btuh, 208 V, 3 ph, 60Hz, 14 amps (Emerson Chromalox MUH-05-8 unit heater, MT-1 thermostat, MMB-5 mounting bracket)
Two 20 amp circuit breaker disconnects in load center (Square D Q0320)3 pole, common trip with indicator

Lights 4 units each unit having 2 lamps, 120V, 6Hz, 70 watts per fixture, .65 amps per fixture (Graybar Meter Miser Wrap-Arounds GMM-8-2224)
One 15 amp ground fault circuit interrupter circuit breaker disconnect in load center for both lights (Square D Q0115GFI) 1 pole with trip indicator

Switch toggle type, 120V, 15 amp (Hubbell 1201 GRY)

Recorder/Totalizers 2 units each being (Chessell Model 390-12-010-10-100 11000 0 Manufacturers calibration records are required for these devises)
Two 15 amp ground fault interrupting circuit breaker disconnects in load center (square D QO115GFI) 1 pole with trip indicator.

Duplex Outlet corrosion resistant, 3 wire grounding, 125V 20 amp (Hubbell 53CM62)
One 20 amp ground fault circuit interupter circuit breaker disconnect in load center (Square D QO120GFI) 1 pole with trip indicator

Loadcenter circuit breaker type, 3ph, 4 wire, 120/208V AC WYE, 100 amp main (Square D QO424M100) flush cover (Square D QOC430LF) Equipment Ground bar kit (Square D PK15GTA)

Safety Socket Box test-bypass type, 3ph, 4 wire, 208Y/120V, 100 amp (Square D EM71NRB)

304 GENERAL MATERIALS

The following types of material and equipment should be used

- Service equipment, panelboards, safety switches, motor starters and other general purpose control devices	- Square D
- Wiring devices	- Hubbell, A.H. & H., P. & S. G. E., Sierra, Grouse-Hinds
- Finishing plates	- Sierra
- Lighting Fixtures	- Noted on Drawings or approved equal
- Lamps	- G.E., Sylvania or Westinghouse

Conduit can be U.L. approved heavy wall rigid or EMT where not otherwise specified. All fittings must be U.L. approved and electrically conductive. Minimum conduit size is 3/4" except where noted. Flexible conduit is 1/2" minimum.

Conduit runs shall be in the block walls and under the concrete floors unless otherwise indicated.

Wire and cable for general wiring shall be rated 600 volt. Conductors size #12 through #8 AWG shall have type THW or THWN insulating wall unless otherwise noted. Conductors sized #6 AWG and larger shall have type XHWHW insulating wall unless otherwise noted. Minimum conductor size must be #12 AWG. All wire terminating in light fixtures or at equipment should be heat resisting type. Wire must be sized so that voltage drop does not exceed 3% from branch panel to last outlet. Color coding should be Phase A - Black, Phase B - Red, Phase C - Blue, Neutral - White or Grey and Ground - Green. All wire must be 98% conductability soft drawn commercially pure copper.

Toggle switches and receptacles should have a grey finish. Finishing plates must be brushed stainless steel.

305 GENERAL INSTALLATION

The Electrical Subcontractor is responsible for all power tie-ins required for installed equipment.

All equipment, switches, panels, main circuits and feeder circuits that are installed by the Electrical Subcontractor should be identified by permanent labels.

The Electrical Subcontractor is responsible for all testing required to insure a complete and secure electrical system.

All conduit shall be hidden from view unless noted on drawings or approved by Owner. No runs will be installed diagonally. Conduit ran through outside walls must be sealed with appropriate material.

Wire must not be pulled using grease or oil. Only cable pulling compounds similar to Y - ER - EASE are to be used. Any required splicing will be done using approved splicing procedures and must be approved by Owner.

All wall mounted switch and outlet boxes must be flush mounted unless otherwise noted.

Mounting height of switch and outlet boxes and devices are to be as follow:

- Receptacle outlets - 40" above floor
- Toggle switches - 48" above floor

306 HEATERS

The Electrical Subcontractor is responsible to furnish, install and wire the electric heaters. The heating fixtures are to be hung from the wall after the wall and ceiling painting are complete. The units specified may be replaced with equal units. Such units shall have a built in thermostat (40° to 85°F range), totally enclosed corrosion resistant elements finned and sheathed, quiet built in fan, totally enclosed motor with sealed bearings automatic-reset thermal cut-out disconnects for element and motor.

307 PANEL BOARD, STARTERS AND METER BOX

100 amp, 3ph, 4 wire, 208Y/120 volt meter box is to be supplied and installed by the Electrical Subcontractor, the unit is to be equal to Square D.

Nema Size 0 starters are to be supplied and installed by the Electrical Subcontractor. The units are to be equal to Square D. They are to be installed after the wall and ceiling painting are complete.

100 amp 120/208 volt circuit breaker panelboard complete with main breaker and listed number of individual breakers is to be supplied and installed by the Electrical Subcontractor. The panel should be equal to Square D.

308 GROUNDING

The conduit system ground must be continuous through all new construction. All equipment must be provided with a suitable ground. Green pigtails and jumpers are to be used with outlets, switches and all flexible conduits. All conduit ground must be tested to insure correct and complete ground and approved by Owner.

309 LIGHTING

The Electrical Subcontractor is responsible to furnish, install and wire all light fixtures. Ceiling fixtures will be hung after ceiling is painted. All ceiling fixtures must be self supporting and also secured to bar joists. All fixtures must be equipped with U. L. heat resistant wiring. Fixtures should have white finish on all metal.

310 SERVICE ENTRANCE WIRING

The service entrance wire size will be #2 AWG. The service entrance conduit will be routed underground to the nearest Power Company pole or ground mounted transformer. The bury depth shall be 18 inches to the center of the conduit. A 2 inch thick by 6 inch wide concrete cover shall be poured in the trench after 6 inches of fill has been compacted over the conduit. A yellow plastic warning tape shall be laid in the trench after 6 inches of soil has been compacted over the concrete cover. The remaining fill shall then be added and compacted. If a ground mounted transformer is to be utilized for the power supply the service entrance conduit shall terminate in the terminal cabinet of the transformer. If a pole mounted transformer is to be utilized for the power supply the service entrance conduit shall extend 12 feet up the pole and have a weather head. The General Contractor will be responsible for coordinating the electrical service connection.

SECTION 400

PAINTING

401 GENERAL

The Painting Subcontractor is responsible to furnish all supplies and labor to paint all interior walls, ceiling, door (interior and exterior), gutters, downspouts, exposed roof flashing, meter box and exposed conduit.

The painting schedule will consist of two segments. All sealing, priming and finish coats will be in the first segment. After other construction is complete touch up will be done.

Care must be taken to protect all adjacent surfaces during preparation and painting. All surfaces should be prepared to paint manufacturers recommendations before painting.

402 MATERIALS AND APPLICATION

Top Coat Paint colors to be used are as follows:

- All exterior metal doors, frames and meter socket box	- Glidden Professional Colors Aluminum
- All galvanized gutters, flushing, downspouts and conduit	- Glidden Professional Colors Aluminum
- All interior walls, ceilings, doors frames and conduit	- Glidden Professional Colors White

Paint types to be used are as follows:

- Exterior Primed Surfaces	- (2) coats Glidden #592
- Exterior Galvanized Surfaces	- (2) coats Glidden Epoxy Chromate Primer #5251/5252 - (2) coats Glidden #592
- Interior Block	- (1) coat Glidden Ultra Hide Block Filler #5317 - (2) coats Glidden Glid Guard Epoxy #5250/5242
- Interior Ceiling, bar joists and conduit (all galvanized)	- (2) coats Glidden Epoxy Chromate Primer #5251/5252 - (2) coats Glidden Glid Guard Epoxy #5250/5242
- Interior Primed metal door and frame	- (1) coat Glidden Universal Fast Dry Metal Primer #5210 - (2) Coats Glidden Glid Guard Epoxy #5250/5242

SECTION 500

DRIVEWAY AND ENTRY WALK

501 GENERAL

The Paving Subcontractor is responsible for labor, material and installation of the drive shown on Reilly Tar & Chemical Corp. drawing number 861737-001. The driveway is to be installed to meet the specifications of the City of St. Louis Park. The Paving Subcontractor is also responsible for the pump house entry walk as shown on Reilly Tar and Chemicals Corp. drawing number 861737-601.

All concrete shall be cured for a period of not less than 7 days. During this curing period, no part of the concrete shall be permitted to become dry. Curing shall be applied and maintained to prevent loss of water from concrete for the duration of the curing period.

Fresh concrete shall be protected from heavy rains, flowing water and mechanical injury. All concrete shall be protected from the sun and drying winds.

Sidewalks and other exterior slabs except vehicular traffic areas shall receive a hair broom finish in accordance with ACI 301, Section 1104(d) with a Class B. tolerance.

Vehicular traffic areas shall receive a medium broom finish.

Exterior concrete slabs shall be cured with Sealtight WP-40 White-Pigmented Concrete Curing Compound as manufactured by W. R. Meadows Elgin, Illinois. or an equal product approved by the Owner. Application for this product shall be 300 square feet per gallon. Product shall meet specifications: ASTM C309, Type 2, Class A; AASHTO M148, Type 2, Class A; ANSI A 37.87, Type 2, Class A.

Concrete testing shall be done on a per truckload basis. Samples shall be taken per ASTM methods and tested by an independent testing laboratory. The laboratory shall be selected by the General contractor and approved by the Owner. The cost of sampling and testing shall be included in the bid price. The owner will evaluate the test results for acceptance or rejection.

SECTION 600

BUILDING

601 GENERAL

This portion of the contract includes the following:

- Foundation construction
- Masonry wall construction
- Wall, roof and floor insullation
- Concrete floor construction
- Brick veneer construction
- Bar joists and decking construction
- Roof scuttle
- Roofing, flashing, nailers, gutters and downspouts
- Door, frame, threshold, hinges, plates and handle
- Lockwork and door closer
- Caulking

All materials and labor required for complete finish are to be included.

All of the Work shall meet the requirement of all governing codes, ordinances, laws, regulations, safety orders and directives.

602 EXCAVATION AND BACKFILL

Provide all equipment, material and labor to excavate for foundations, footings, stoops, sidewalks, curbs, retaining walls and similar items, all to the lines and grades indicated herein and on the drawings.

Excavate to full depth and full width of foundations; allow ample room for forms where required. Excavation shall be held to a true line and grade. Bottom shall be level and free from loose material. Where bottom of footing is undercut, return to grade with concrete of same quality as specified for the footing of foundation.

Promptly backfill excavations as work permits, but not before walls have attained design strength. Shore walls and footings as required to prevent toppling, cracking, and misalignment.

All spaces excavated for and not occupied by structures shall be backfilled to subgrade with excavated materials from the site or bank-run gravel from off-site and thoroughly compacted in layers not to exceed 12" in depth. Backfill shall be compacted to a minimum of 95% of maximum density at optimum moisture content, as determined by Modified Proctor Test (ASTM D-1557). Backfill simultaneously on both sides of the structures.

Excess excavated material not used as backfill, but suitable for site fill, shall be used for site grading as directed by the Contractor.

Excavated material deemed unsuitable for backfilling or fill will be disposed of by the Owner.

Fill material required to complete the finish grading will be bank-run gravel for subgrade and top soil as required to meet the minimum coverage requirement of 6 inches. All additional materials for the building excavation and general site grading shall be provided by the Contractor.

Place granular drainage fill under the slab and compact. Depth of drainage fill shall be minimum 6 inches or as shown on drawings.

Earthwork density tests shall be required for each lift during construction. They shall be made by an independent testing laboratory selected by the Earthwork Subcontractor and approved by the Owner. Field density tests shall be taken at locations selected with a minimum of one per 150 sq. ft. per 2' lift. All tests required to bring compaction to the required density shall be paid for by the Building Earthwork Subcontractor.

603 CONCRETE

This section includes general requirements for the concrete Subcontractor and is intended to supplement the specifications listed on the drawings.

Reinforcing bars shall conform to the requirements of ASTM A-615 "Specifications for Deformed Billet-Steel Bars for Concrete Reinforcement. The grade of steel to be as shown on drawings.

Welded wire fabric shall conform to the requirements of ASTM A-185, "Standard Specifications for Welded Steel Wire Fabric for Concrete Reinforcement".

Expansion Material shall be ASTM D1752, Type III, preformed, self-expanding strips formed of cork particles with a nonbitumen, isolable resin binder, similar to "W.R. Grace Code No. 4324."

Vapor barrier material shall be 6 mil polyethylene ASTM E-96.

All materials and labor required for complete finish are to be included.

All of the Work shall meet the requirement of all governing codes, ordinances, laws, regulations, safety orders and directives.

Provide Expansion Joint Material where indicated on Drawings. Install preformed, self-extending granulated cork strips full depth of joints.

Interior concrete slabs shall be cured with Clear Bond as manufactured by Guardian Chemical Company, Atlanta, Georgia or approved equal by the Owner that can be applied in one coat at the rate of 400 square feet to the gallon and shall meet ASTM C309 (Type 1), TTC-00800 (GSA-Fss), CRD-C-300 and U.S. Corps of Engineers Abrasion Test Method.

Preparation: All work shall be in accordance with ACI-614-59, "Recommended Practice for Measuring, Mixing and Placing Concrete". ACI-614-59 will be republished as ACI-304. All construction debris and extraneous matter shall be removed from within the forms. Struts, stays, bracing and blocks, servicing temporarily to hold the forms in correct shape and alignment, shall be removed. All concrete shall be place on clean damp surfaces, free from water, or upon properly consolidated fills.

Vibration: Concrete shall be consolidated by means of mechanical vibrating. Vibrators shall be inserted and removed vertically at regular intervals to insure uniform consolidation. In no case shall vibrators be used to transport concrete inside the forms. Internal vibrators shall maintain a speed of not less than 7,000 impulses per minute when in operation. At least one standby vibrator shall be on hand at all times.

Cold Weather Batching: No frozen materials or materials containing ice shall be used in cold weather. Temperatures of materials including mixing water, shall not exceed 140°. When placed in forms, the concrete shall have a temperature between 50°F. and 90°F. Work shall be in accordance with ACI-306, "Recommended Practice for Winter Concreting".

Top surface of footings shall receive a floated finish with a Class B tolerance (1/4 inch in 10 feet).

All interior floor slabs shall receive a troweled finish in accordance with ACI 301, Section 1104(c) with a Class A tolerance (1/8 inch in 10 feet).

All concrete shall be cured for a period of not less than 7 days. During this curing period, no part of the concrete shall be permitted to become dry. Curing shall be applied and maintained to prevent loss of water from concrete for the duration of the curing period.

Fresh concrete shall be protected from heavy rains, flowing water and mechanical injury. All concrete shall be protected from the sun and drying winds.

604 HARDWARE SPECIFICATIONS

Door Lockset (To match existing City Utility Dept. Facilities and keyed alike)

Roof Scuttle Pad Locks (Master, keyed to City Utility Dept. System)

Door Closer (Yale Series 50, standard door closer #54)

Door Hinges (3) Full Mortise, standard weight, wrought steel, Anti-friction ball bearing, non rising pin, flush tip, Non-Removable Pins, Satin Chrome finish (Stanley FBB179-26D-NRP)

Roof Scuttle (Bilco Type S-50)

605 MASONRY WALL CONSTRUCTION

The door opening shown on the drawing is to have a reinforced lintel. Construction materials should be 6" & 12" ASTM C90, Grade N, Type 1 hollow core block and Type S mortar.

Face brick shall be standard size (2-1/4" x 3-3/4" x 8"), grade SW, conforming to ASTM designation C216. Color and style to be specified by the Owner.

Wall reinforcing shall be truss type, 9 gauge steel wire conforming to ASTM A82, with side rods deformed. Placed as shown on drawings. Standards: Truss-Mesh (Hohmann & Barnard) - Dur-O-Wall (Dur-O-Wall Mfg. Co.) - Keywall Truss (Keystone).

Mortar joints which are to be exposed or painted shall be struck off flush with the wall surface and when the mortar is partially set, shall be firmly compacted with a round jointing tool. Mortar joints in the face of walls to be covered shall be struck off flush with the face of the wall.

The Masonry Subcontractor shall cooperate with all trades and be responsible for cutting, patching and building-in all work as required.

The door frame is to be grouted

Set and build-in flashings and counter flashings, expansion joints, frames, sleeves, lintels, and anchor inserts, furnished under other Sections, which are incidental to, or support masonry.

Anchors embedded in masonry shall be furnished and installed by the Masonry Contractor. Size and spacing will be shown on drawings.

Flashing, expansion and control joints shall be built-in to masonry and placed as the work progresses. Provide weep holes 24" o.c. at bottom of walls (floor line) and bottom of flashings.

Exterior brick and stone walls above grade shall receive silicone or stearate water-repellent, applied in accordance with manufacturer's instructions. Standards: Toch Brothers - Supertox; Sonneborn S-X Hycon; Toch Brothers Limestone Supertox; Sonneborn Hydrocide Unipel.

All permanently exposed masonry walls, including partitions shall be thoroughly cleaned down on completion, damaged surfaces repaired or replaced and mortar joints pointed to leave the work in a condition acceptable to the Owner. Cleaning and pointing shall be started at the top and worked down. Cleaning of MASONRY, except concrete block and stone, shall be done with fiber brushes using soap powder boiled in water, adding clean, sharp, fine sand to the soap and water mixture where necessary. Excess MORTAR STAINS shall be removed and the entire surfaces rinsed with clean water. Cut out defective mortar joints where necessary and fill the crevices solidly with motar and tool as specified. EXPOSED CONCRETE BLOCK to be rubbed with stone to eliminate excess mortar. Point up all surfaces and leave walls in a condition acceptable to the Owner.

No masonry work shall be permitted when the temperature is less than 32 degrees F. or below 40 degrees F. and falling, unless the following precautions are taken:

1. Below 40 degrees F. but above 32 degrees F.: Heat mortar mixing water, but not above 160 degrees F. Plastic sheets or tarpaulins shall be placed over the newly laid walls.

2. Below freezing, but above 0 degrees F.: In addition to the preceding requirements, sand shall be heated, but not scorched. The working area shall be enclosed with protective coverings and artificial heat shall be provided. When the temperature falls below 20 degrees F., all concrete masonry units shall be heated to at least 50 degrees F. at the job site by the Contractor.

3. Below 0 degrees F.: Construction shall be stopped unless the enclosure is complete and tight. Observe all preceding requirements.

   Masonry shall be protected against freezing for at least 48 hours.

   No masonry shall be laid with or on frozen materials.

606 SUPPLY AND INSTALL DOOR

Hollow metal door and frame are to be supplied and installed. Doors are to be Steelcraft Corp. or approved equal. Door and frame are to be factory primed. Frame is to be grouted. The door is to be fitted with a top cap.

The frame is to be checked for level during construction to assure it remains plumb.

Finish hardware shall be equal to the following:

- Hinges	- Hager, Stanley, McKinney
- Door closer	- Sargent & Co., Yale
- Threshold	- National Guards Products Co.
- Butts	- The Stanley Works

607 SUPPLY AND INSTALL LOCKWORK

The lockwork to be used is as follows:

- Door	- To match existing city installations
- Roof Scuttles	- Master, pad lock

All lockwork except pad lock is to be satin chrome and be keyed to meet City of St. Louis Park specifications.

608 CAULKING

Provide all labor, materials, and equipment necessary for complete caulking work as shown on drawings and specified herein.

All caulking work shall be performed by an experienced, competent Caulking Contractor as per requirements herein.

Interior Caulking: same as exterior.

Exterior Caulking: shall be of a color to closely match the mortar color, 2 part polysulfide base (Thiokol) sealant material meeting requirement of American Standard Specifications for Sealing Compounds for the Building Trade, A116.1 1960 of Shore A or approved equal.

Primer: colorless by caulking manufacturer.

All materials shall be used in accordance with their manufacturer's latest printed instructions.

Caulk expansion joints, control joints, and around entire perimenter of doors and other openings and joints where caulking is otherwise indicated or obviously required on exterior of building(s).

Mix compounds which require field mixing as per manufacturer's instructions. Apply with gun especially for compound, to attain a smooth finish surface, free of wrinkles, air pockets and holes. Compress into joint with tooling rods or paddles to insure conformance of compound to even the smallest surface irregularity. Depth of joint shall be as recommended by Manufacturer of the sealant material. Pack joints required with sealant backer to bring voids to required depth before caulking.

SECTION 700

DISCHARGE PIPE AND GRAVITY DRAIN

701 GENERAL

This Section describes work, equipment and materials to be furnished by the Sewer Subcontractor.

All sewer systems are to be finished to a ready-to-operate condition. The Sewer and Manhole Subcontractor is responsible for completing all sewer systems except for pump discharge and floor drain piping installed under the building foundation and slab.

The accompanying drawings have been drawn close to scale and have some listed dimensions. Care has been taken to maintain accuracy, but it remains the Contractor's responsibility to verify the scaled and listed dimensions.

The Sewer and Manhole Subcontractor bid shall include a list describing the major types of equipment and materials to be used. After acceptance of the bid, changes to this list will not be allowed.

The Sewer and Manhole Subcontractor will assume all responsibility for conforming to rules and regulations of the applicable government agencies and utilities.

The Sewer installation will comply with all specifications of the City of St. Louis Park. All piping that is not installed to a depth of 7.5 ft. shall have a covering of 2 inches of polyurethane insulation covered with a polyethylene jacket.

The invert elevations of the discharge and drain pipes are to be a minimum of 4 feet 6 inches below grade.

Excavations shall meet local and state safety regulations as applicable.

Backfilling is to be done to the specifications of the City of St. Louis Park.

Elevation and layout drawings will be provided to the City by the Sewer Subcontractor.

All construction permits will be obtained by the owner.

702 LAYING OF PIPE

All pipe shall be laid on undisturbed earth. If earth is disturbed or soft the loose earth should be cleared out and replaced with compacted gravel.

703 DRAINAGE AND SEWAGE CONTROL

The Subcontractor shall remove by well points, pumping, bailing, or other acceptable method any water which may accumulate or be found in the trenches or other excavations to be made. He shall take all necessary precautions to keep the trenches and other excavations entirely clear of water during construction of sewers and structures. Newly laid concrete shall be adequately protected from injury resulting from ground water or sewage or from the handling or disposal of water or sewage. No drainage ditches shall be placed within the area to be occupied by any structure except as permitted by the Contractor. Upon completion of new construction, existing sewers shall be restored or otherwise provided with adequate outlets. Permits will be obtained by the owner if necessary.

The Subcontractor shall at all times have upon the job sufficient pumping equipment ready for immediate use to carry out the intent of this section.

This Subcontractor shall at no time permit effluent contaminated by raw sewage to enter any storm sewer or open ditch.

Where existing sewers or drains are encountered in this work, adequate provisions shall be made for diverting the flow in the existing sewers so that the excavation will be kept dry during the progress of the construction work. Upon the completion of the construction work, the existing sewers shall be restored or otherwise provided with an adequate outlet as directed by the Owner.

704 BACK FILLING

As soon as practicable after the pipes or conduits are constructed and inspected, the trench shall be backfilled. At the sides and top from the subgrade to a level at least one foot above the top of the pipe, selected granular material shall be deposited and carefully compacted by hand or machine tamping or water flushing in layers not to exceed six inches in depth.

In undeveloped property the backfilling shall be completed using the available excavated material, free from boulders, rock, stones, lumber, masonry, debris, or organic material. Backfill shall be compacted to a minimum density equal to the adjacent area, as determined by the standard proctor density procedure ASTM D-698. The remaining backfilling of the trench shall be carried up to limits directed by by the owner with suitable allowance for shrinkage.

Backfilling in areas beneath streets or other paved areas shall be accomplished with pit-run sand or gravel, thoroughly compacted in layers not to exceed 8" in depth for the full depth of the trench. Backfill shall be compacted to a minimum of 95% maximum density at optimum moisture content, as determined by the Modified Proctor Test, ASTM D-1557. Subcontractor shall maintain all such areas in a condition satisfactory to the city until permanent repairs are made.

If there is not sufficient excavated material suitable to meet the requirements for backfilling material, the Subcontractor shall make up the deficiency by transporting suitable surplus material from excavations on other parts of the Work to complete the backfill. If still deficient then material shall be hauled from offsite by the Subcontractor.

All material hauled on site for fill or backfill shall be loose dry earth, sand, gravel or bank-run gravel. Aminimum of 6 inches of topsoil shall be used to cover all backfilled and filled areas.

Wherever gas mains, water mains, sewers, etc. cross the sewer trench, 3000 psi design strength concrete shall be used for backfill beneath them. This backfill shall extend from the bottom of the trench up to spring line of the pipe crossing the trench. A rough wooden form shall be used to hold the concrete in place. The thickness of the backfill shall be 6 inches greater than the diameter of the crossing pipe. Concrete so required shall be considered as incidental to the Work.

705 DISPOSAL OF UNSUITABLE MATERIAL

Excavated material shall be used in backfilling around sewers and other structures unless determined by the Owner to be unsuitable. Unsuitable material will be disposed of by the Owner.

706 ROADWAY REPAIR

This work shall include the replacement of all roadway surface damaged or removed due to the construction of the sewers and appurtenant structures. All such work shall be done in accordance with the specifications of the City of St. Louis Park. No permanent road surface repair shall be made until the backfill in the trench and around manholes has settled and the city has given their approval to make such repairs. The maintenance of temporary road surfaces during the peirod of settlement is specified hereinbefore under 704 BACKFILLING. All repairs shall be same type and at least equal to existing pavements. Edges of existing pavement parallel to trench shall be cut to a neat line prior to making a repair.

All the work necessary to make repairs to road surfaces will be included in the bid for sewer construction.

707 WATER TESTS OF DISCHARGE AND DRAIN PIPES

See Mechanical Work Section 202 System Testing

708 PIPING MATERIALS

See Mechanical Work Sections 207 Discharge Water Piping and 208 Drain Piping

APPENDIX E

CONTINGENCY PLAN

CONTINGENCY PLAN

This Contingency Plan outlines the course of action to be taken if contaminated drilling fluids, cuttings, debris or water are encountered during the activities described in the Site Management Plan. For the purpose of this Contingency Plan, contaminated materials are defined as follows:

Solids containing creosote or coal tar constituents will be classified as contaminated if the creosote or coal tar constituents exceed half of the solid mass.

Groundwater or drilling fluids will be classified as contaminated if the water exhibits a discernible oil phase or sheen.

In the event that contaminated soils are encountered during excavation for foundations or underground piping, they will be handled as described in the Site Management Plan. In the event that contaminated water is generated during excavation work, it will be handled as described in this Contingency Plan.

Handling of Contaminated Solids

For activities whose duration exceeds one workday, contaminated solid materials will be placed in an isolated location at the work site immediately upon exposure or generation. The location will be secured by eight-foot, chain-link fence with locked gates. Silt fencing will be placed inside the fence to control the migration of contaminated material from the area. The ground surface within the isolation area

will be covered with an appropriate impervious barrier capable of withstanding the deleterious chemical properties of creosote or coal tar materials. Appropriate storage vessels will be provided within the secured area and utilized for containerization of contaminated materials as appropriate to meet the intent of this Contingency Plan. Materials not considered applicable for containerization on the site will be stockpiled on the impervious barrier for subsequent loading onto transport vehicles. Stockpiled materials will be covered with an impervious barrier at all times, unless work is underway which affects (i.e., adding to or removing from) the stockpile.

For activities whose duration is one workday or less, contaminated materials will be removed from the work site before workday's end, if possible. If contaminated material cannot be removed by workday's end, the material will be placed in a secured area at the site as described above.

The handling of contaminated solid material, including its loading into appropriate storage vessels or placement in an isolated location on site, and its release to a transporter licensed to haul said wastes will be in accordance with the provisions of applicable regulations. Contaminated solid materials scheduled for off-site disposal will be transported to a RCRA hazardous waste TSD facility in accordance with the provisions of applicable regulations.

In the event the activity contemplated within the Site Management Plan is addressed in Section 11.5 of the RAP, contaminated soil that has been excavated will be replaced in approximately its original location and covered by clean soil to a depth of at least 12 inches.

In the event the activity contemplated within the Site Management Plan generates relatively small amounts of contaminated solid material, the contaminated material may be replaced in approximately its original

location, in which case it will be covered by clean soil to a depth of at least 12 inches. The determining factor in deciding whether contaminated materials may be returned to their original location will be the likely effects of such action on accomplishing the technical objectives of the RAP.

Handling of Contaminated Liquids

In the event that contaminated liquids are encountered or generated during the conduct of the work described in the Site Management Plan, the liquids will be pumped to the sanitary sewer if they contain less than ten percent organic material. Estimates of flow rate and disposal volume will be established and the Metropolitan Waste Control Commission (MWCC) will be informed before the discharge to the sewer if the estimated flow exceeds 150 gallons per minute per workday. Contaminated liquids containing more than ten percent organic material will be handled as solid material under the terms of this Contingency Plan.

Any drilling equipment with visible contamination will be steam cleaned upon completion of well construction or reconstruction work. The resulting rinsate will be handled in accordance with the provisions of this Contingency Plan.

Handling of Noncontaminated Materials

Solid material which is not contaminated -- as defined in this Contingency Plan -- yet appears to contain creosote or coal tar constituents will be retained at the work site. The material will be replaced in approximately its original location, or if not all affected material can be so placed, a second excavation will be completed at the work site for burying the material. In either case, the affected material will be covered with at least 12 inches of clean soil.

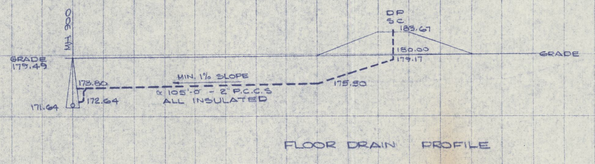
Unaffected excavated material taken from the second excavation will be removed from the site and affected material will be returned in its place.

Uncontaminated water (no discernible oil phase or sheen) resulting from the activities described in the Site Management Plan will be disposed of in the storm sewer or by any other means acceptable to the City of St. Louis Park.

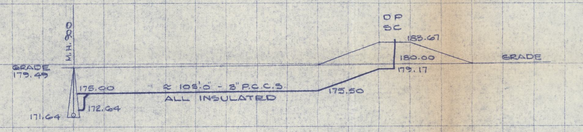
Communications

The Reilly Project Leader or Alternate Project Leader will inform the EPA, MPCA and City of St. Louis Park Project Leaders or Alternates of the status of actions taken pursuant to this Contingency Plan. Such notification may be oral or written, as agreed by the Project Leaders.

All actions, decisions and communications by the Reilly, City, EPA and MPCA Project Leaders in implementing this Contingency Plan will be in accordance with and are subject to the provisions of Parts I, J and O of the Consent Decree.

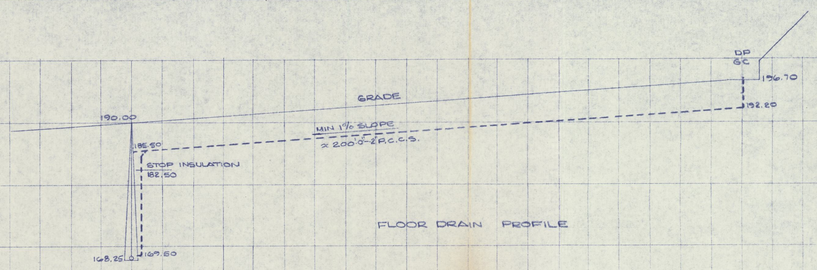


FLOOR DRAIN PROFILE

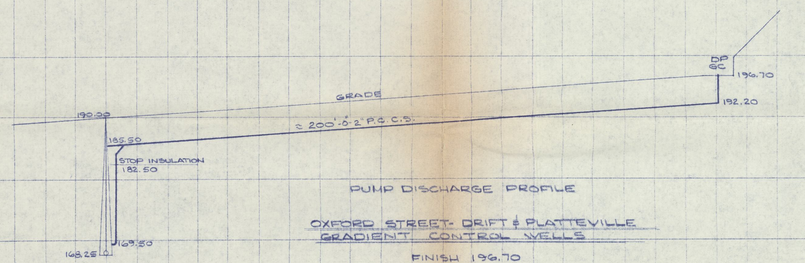


PUMP DISCHARGE PROFILE

LAKE STREET - DRIFT & PLATTEVILLE
SOURCE CONTROL WELLS
EXIST. 180.00
FINISH 193.07

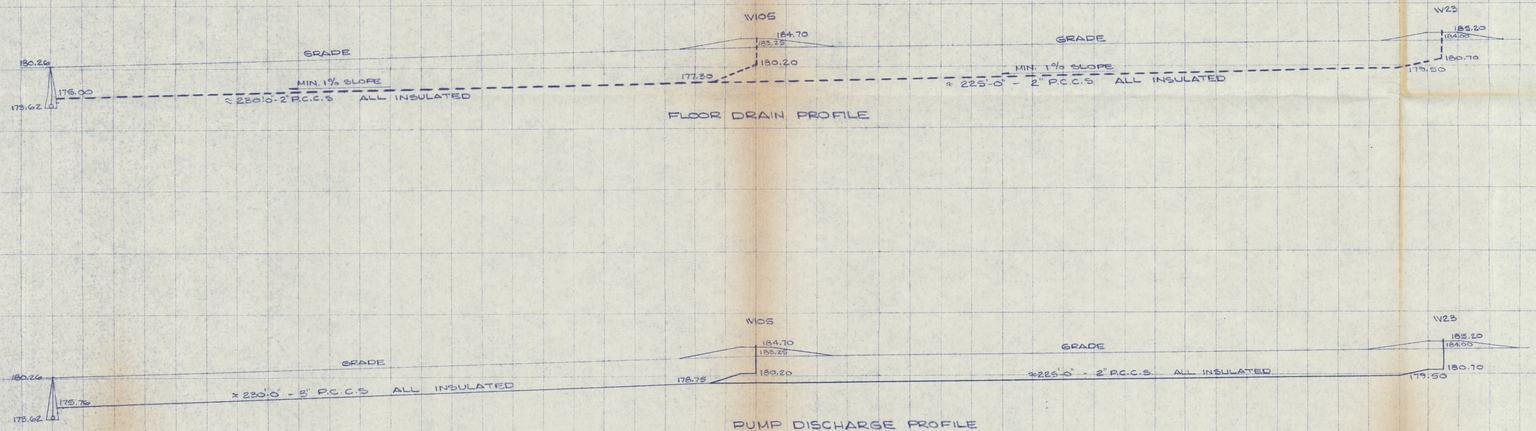


FLOOR DRAIN PROFILE



PUMP DISCHARGE PROFILE

OXFORD STREET - DRIFT & PLATTEVILLE
GRADIENT CONTROL WELLS
FINISH 196.70



FLOOR DRAIN PROFILE

PUMP DISCHARGE PROFILE

LOUISIANA AVE. W105 & W23
SOURCE CONTROL WELLS

W105	W23
EX. 183.25	EX. 184.00
FIN. 184.70	FIN. 185.20

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

Lewis D. Locke, Jr.

Date 1/23/87 Reg. No. 017565

NOTE:
ALL PIPE ELEVATIONS ARE THE INVERT ELEVATION
---- REPRESENTS FLOOR DRAIN LINES
——— REPRESENTS PUMP DISCHARGE LINES

JAN 26 1987

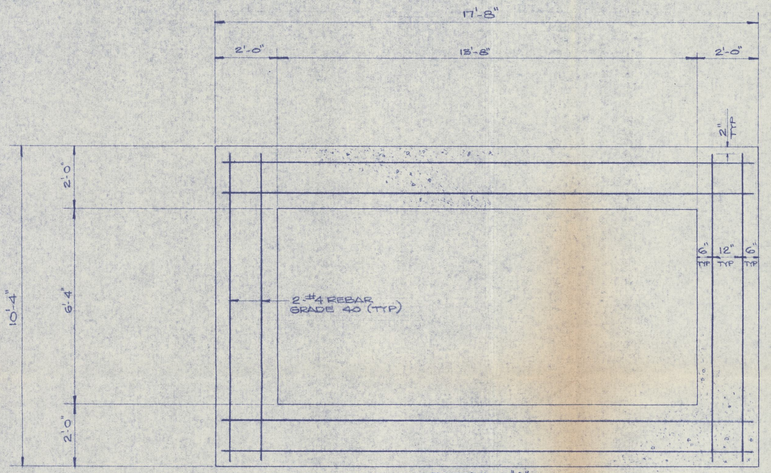
PHOTOSTAT	DATE:
MICRO FILM	DATE:

REVISIONS						REVISIONS						REVISIONS						REFERENCE DRAWINGS	
NO.	DATE	BY	DESCRIPTION	CHK'D	APP'D	NO.	DATE	BY	DESCRIPTION	CHK'D	APP'D	NO.	DATE	BY	DESCRIPTION	CHK'D	APP'D	DRAWING NUMBER	DESCRIPTION

REILLY TAR & CHEMICAL CORPORATION
INDIANAPOLIS INDIANA

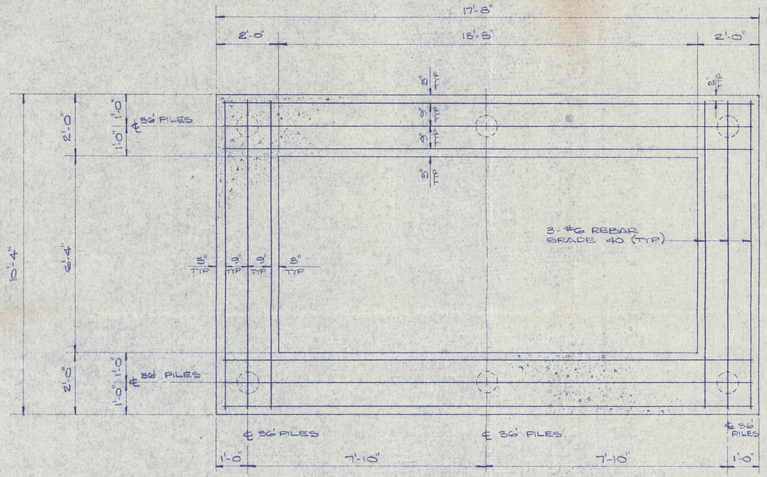
UNDERGROUND PIPING PROFILES

DRAWN BY	DATE	CHECKED BY	DATE	PLANT	REVISION
AK	1/22/87	[illegible]	1/23/87	St. LOUIS PARK, MINN.	
SCALE HORIZONTAL: 1" = 20' VERTICAL: 1" = 10'		APPROVED BY [illegible]	DATE 1/23/87	DRAWING NUMBER 661737-300	



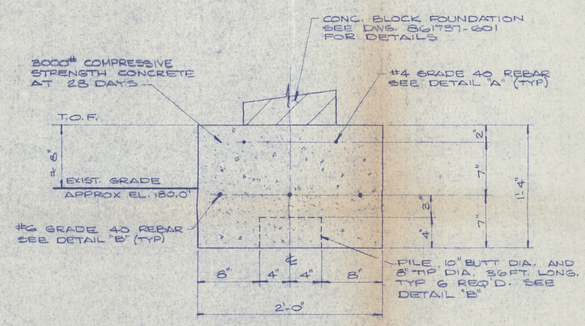
NORTH

DETAIL "A"
REINFORCING TOP OF FOOTING
SCALE: 1/2"=1'-0"



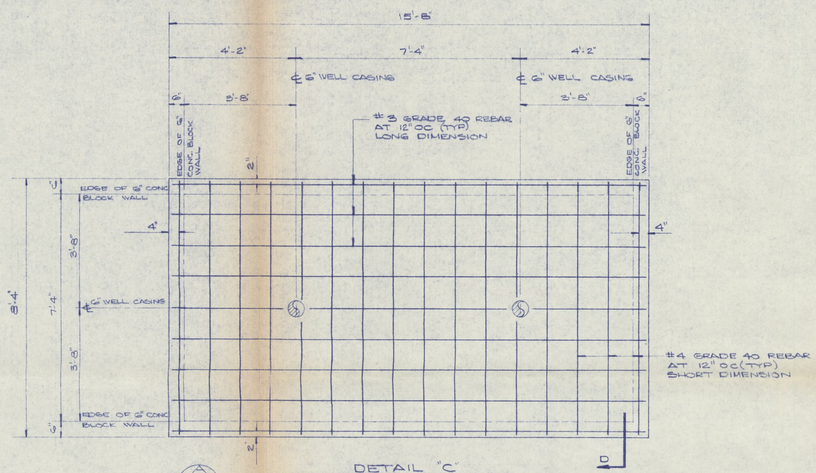
NORTH

DETAIL B
REINFORCING BOTTOM OF FOOTING
SCALE: 1/2"=1'-0"



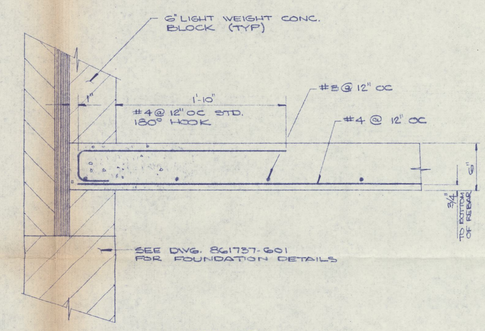
TYP. SECTION
SCALE: 1/2"=1'-0"

DETAIL 1
FOOTING DETAIL FOR DRIFT & PLATTEVILLE
SOURCE CONTROL WELLS BUILDING
SCALE AS NOTED



NORTH

DETAIL "C"
CONCRETE FLOOR REINFORCING
SCALE: 1/2"=1'-0"



SEC D
TYP FLOOR SECTION
SCALE: 1 1/2"=1'-0"

DETAIL 2
CONCRETE FLOOR DETAILS FOR DRIFT AND
PLATTEVILLE SOURCE CONTROL WELLS BLDG.
SCALE AS NOTED

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

Lewis D. Locke Jr.

Date 10/31/86 Reg. No. 017565 D

LEWIS D. LOCKE JR. CIVIL ENGINEER 017565 D REGISTERED MINNESOTA

JAN 26 1987

PHOTOSTAT	DATE:
MICRO FILM	DATE:

REVISIONS						REVISIONS						REVISIONS						REFERENCE DRAWINGS	
NO.	DATE	BY	DESCRIPTION	CHK'D	APP'D	NO.	DATE	BY	DESCRIPTION	CHK'D	APP'D	NO.	DATE	BY	DESCRIPTION	CHK'D	APP'D	DRAWING NUMBER	DESCRIPTION

REILLY TAR & CHEMICAL CORPORATION
INDIANAPOLIS INDIANA

MISCELLANEOUS DETAILS

DRAWN BY	DATE	CHECKED BY	DATE	PLANT	REVISION
AK	10/31/86	[illegible]	10/31/86	ST. LOUIS PARK, MINN.	
SCALE		APPROVED BY	DATE	DRAWING NUMBER	
INDICATED		[illegible]	10/31/86	861737-604	

WELL COMPONENT SCHEDULE						
WELL	DISCHARGE SIZE	(1) POWELL GATE VLV. FIG./SIZE	(2) KATES FLOW CONTROLER / SIZE	(3) HERSEY TURBINE METER W/ TOTALIZER / SIZE	(4) TRW MISSION DUO CHECK II / SIZE	(5) FEBCO REDUCED PRESS. BACKFLOW PREVENTER
DRIFT SC	2" REDUCE TO 1½"	500/ 1½" NPT	4 FAI-1 / 1½" NPT	MVR 100-C-1-150-T-G-N/ 1½" INCREASE TO 2" AFT. METER	K15HMF/ 2"	825Y/1½" NPT
PLATEVILLE SC	2 REDUCE TO 1½"	500/ 1½" NPT	4 FAI-1 / 1½" NPT	MVR-100-C-1-150-T-G-N/ 1½ INCREASE TO 2" AFT. METER	K15HMF/ 2"	825Y/1½" NPT

NOTES:

1. TREATED 4X4 MUST BE CUT DOWN FOR A TOTAL THICKNESS OF 2⅛" TO MATCH INSULATION THICKNESS. (2) TREATED 2X8 MUST BE CUT DOWN FOR A TOTAL THICKNESS OF 2½" TO MATCH BAR JOIST BEARING END THICKNESS.
2. ¾" RIGID CONDUIT IN WALL TO BOXES ABOVE EACH LIGHT AND BOXES BEHIND HEATERS, THEN FLEX CONDUIT TO LIGHTS AND HEATERS.
3. THE HERSEY FLOW METER WILL HAVE AN R-38 ELECTRONIC PULSE OUTPUT DEVISE THAT WILL SIGNAL A MODEL 1005 PULSE TO D.C. CONVERTER WHICH WILL SEND OUTPUT TO THE CHESSELL 390 RECORDER/TOTALIZER

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

Date 10/20/86 Reg. No. 01756 80

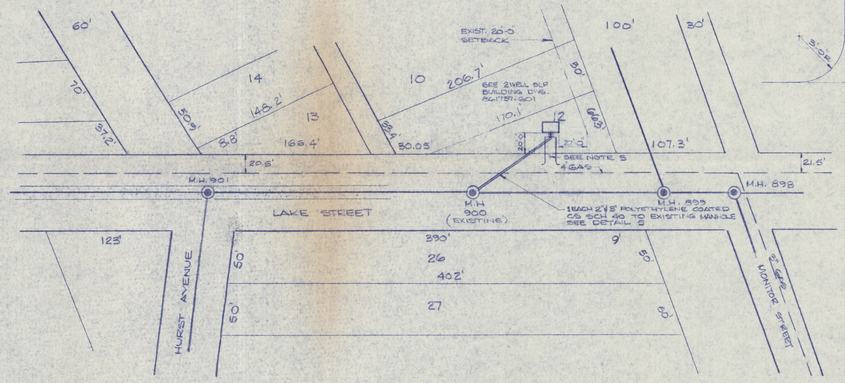
JAN 26 1987

PHOTOSTAT	DATE:
MICRO FILM	DATE:

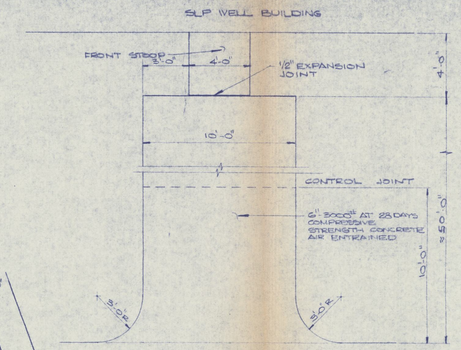
REILLY TAR & CHEMICAL CORPORATION
INDIANAPOLIS INDIANA

DRIFT & PLATTEVILLE SOURCE CONTROL WELLS BUILDING

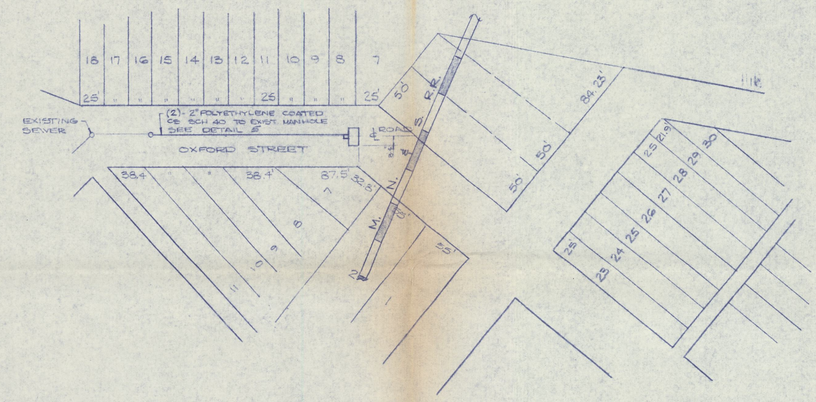
DRAWN BY	DATE	CHECKED BY	DATE	PLANT	REVISION
AK	6/18/86		7/22/86	ST. LOUIS PARK, MINN.	III
SCALE		APPROVED BY	DATE	DRAWING NUMBER	
INDICATED			7/22/86	861737-601	



DETAIL 1
LAKE STREET 2 WELL SLP BLDG
SCALE: 1" = 60'
SEE ELEVATIONS ON DWG. 861757-800

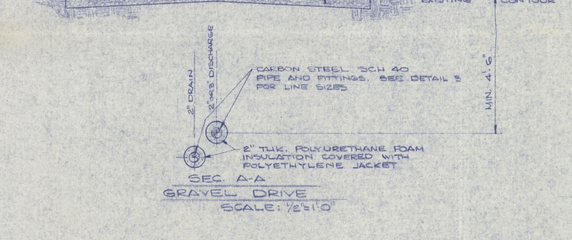


DETAIL "A"
CONCRETE DRIVE
SCALE: 1/4"=1'-0"

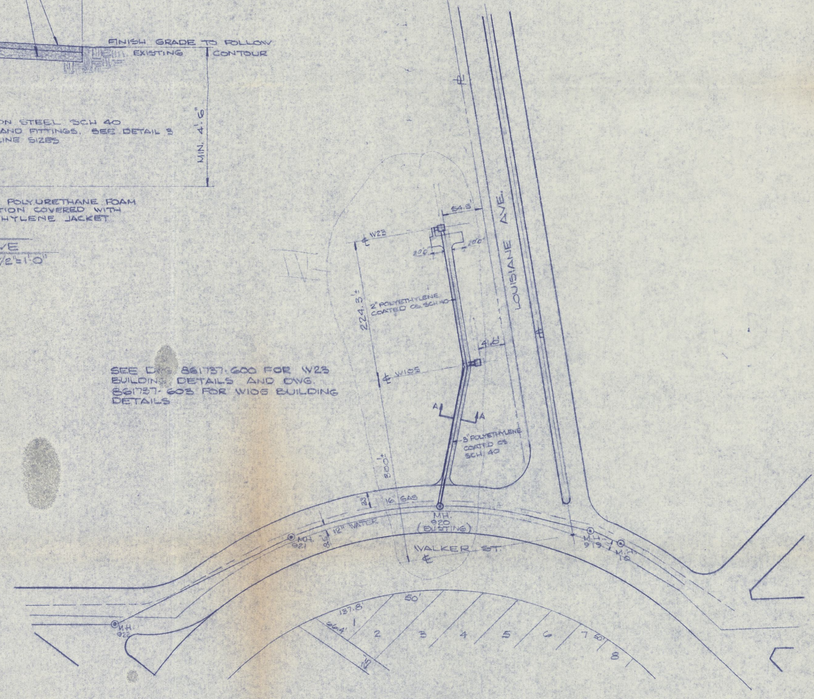


SEE DWG. 861757-602 FOR BUILDING DETAILS

DETAIL 2
OXFORD ST. 1 WELL SLP BLDG
SCALE: 1" = 60'
SEE ELEVATION ON DWG 861757-800



SEC. A-A
GRAVEL DRIVE
SCALE: 1/2"=1'0"

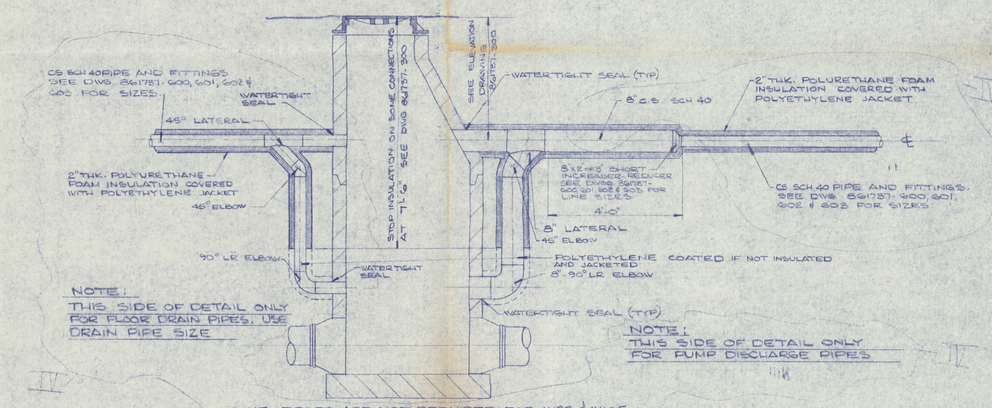


SEE DWG. 861757-600 FOR W23 BUILDING DETAILS AND DWG. 861757-605 FOR W105 BUILDING DETAILS

DETAIL 3
LOUISIANA AVE. 1 WELL SLP BLDG S.
(2 REQ'D)
SCALE: 1"=100'
SEE ELEVATIONS ON DWG. 861757-800

NOTES:

3 EXTEND DRIVE TO STREET



NOTE:
THIS SIDE OF DETAIL ONLY FOR FLOOR DRAIN PIPES; USE DRAIN PIPE SIZE

NOTE:
THIS SIDE OF DETAIL ONLY FOR PUMP DISCHARGE PIPES

LINE DROPS ARE NOT REQUIRED FOR W23 & W105

DETAIL 5
TYPICAL CONNECTION TO EXISTING MANHOLE FOR DISCHARGE PIPES AND FLOOR DRAINS
NO SCALE
SEE DWG. 861757-500 FOR ELEVATIONS

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

Date July 22, 1986 Reg. No. 017565

JAN 26 1987

PHOTOSTAT	DATE:
MICRO FILM	DATE:

REVISIONS

NO.	DATE	BY	DESCRIPTION	CHK'D	APP'D
IV	1/20/87	AK	REMOVED DETAIL 4 AND NOTES 1 & 2, CONNECTED SEWER LINES FROM W23 & W105 TO M.H. 900. ALSO ADDED NOTES MARKED		
III	10/29/86	AK	REVISED INLET/OUTLET LINE SIZES AND ARRANGEMENT AT EXISTING MANHOLE		
II	10/16/86	AK	REVISED ORIENTATION OF WELL HOUSE, CURVED NOTE 1, ADDED NOTES #3 AND DETAILS A, B & SEC A-A, CHANGED DETAIL 4		
I	7/7/86	AK	ADDED DETAIL 4 & CALLED OUT NEW LINES & MHS.		

REFERENCE DRAWINGS

DRAWING NUMBER	DESCRIPTION

REILLY TAR & CHEMICAL CORPORATION
INDIANAPOLIS INDIANA

ST. LOUIS PARK WELL LOCATIONS

DRAWN BY	DATE	CHECKED BY	DATE	PLANT	REVISION
AK	6/27/86		7/7/86	ST. LOUIS PARK, MINN.	IV
SCALE: INDICATED		APPROVED BY	DATE 7/7/86	DRAWING NUMBER 861757-001	